

Mobility as a Service from an equity perspective

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Preface

This report is the last part of the TU Delft Master Program Engineering and Policy analysis. Besides, the thesis is commissioned by international research and consultancy company, Panteia. In February 2020 I started my internship at Panteia in Zoetermeer. Together with my master thesis committee and mentor of Panteia, Eline Jonkers, we came up with the goal to uncover the potential effects of MaaS on transport related social exclusion within the Dutch society. At the time I started my internship I had read about the relatively new mobility concept MaaS, but had never even heard of the transport related social exclusion concept. Therefore, the past six months have been challenging, but I really liked it to work on these complex concepts. In the master program I have learned to take into account the social impacts of a technological innovation. This research led to an even better understanding of social impacts that are difficult to identify. Despite the difficulties as the result of the Covid-19 pandemic, I really enjoyed my time at Panteia and the pleasant weekly feedback moments with Eline Jonkers.

During my thesis I met many interesting people, who were all willing to help me during my master thesis despite the Covid-19 pandemic. I would like to thank everyone that contributed to my thesis. A special thanks to Panteia and my first supervisor Jan Anne Annema for the useful input and sometimes mental support. Last but not least I would like to thank my thesis committee from the TU Delft for the useful feedback during my kick-off and greenlight meeting.

I enjoyed this last challenge I had to overcome in order to finish my master Engineering and Policy Analysis.

Enjoy the read!,

Jesper Kloeke
Delft, July 2020

Summary

In 2014 Hietanen envisioned Mobility as a Service (MaaS), which is a global hype ever since. The relatively new mobility concept, MaaS, is suggested to meet the mobility needs of the end-users in a sustainable, affordable and user's flexible manner (MaaS Alliance, 2019). The ambition of MaaS is to offer travelers seamless mobility solutions based on their travel needs. In order to make use of MaaS the citizens need to have a digital device to connect with the MaaS service, because the mobility provided by the provider can only be purchased with a device connected with the MaaS platform (Li & Voege, 2017). The end-users, customers of mobility, are enabled through the MaaS interface to plan, book and pay their trip. These characteristics of MaaS resulted in a demarcation of what is understood by MaaS in this research (Figure: 0.1).

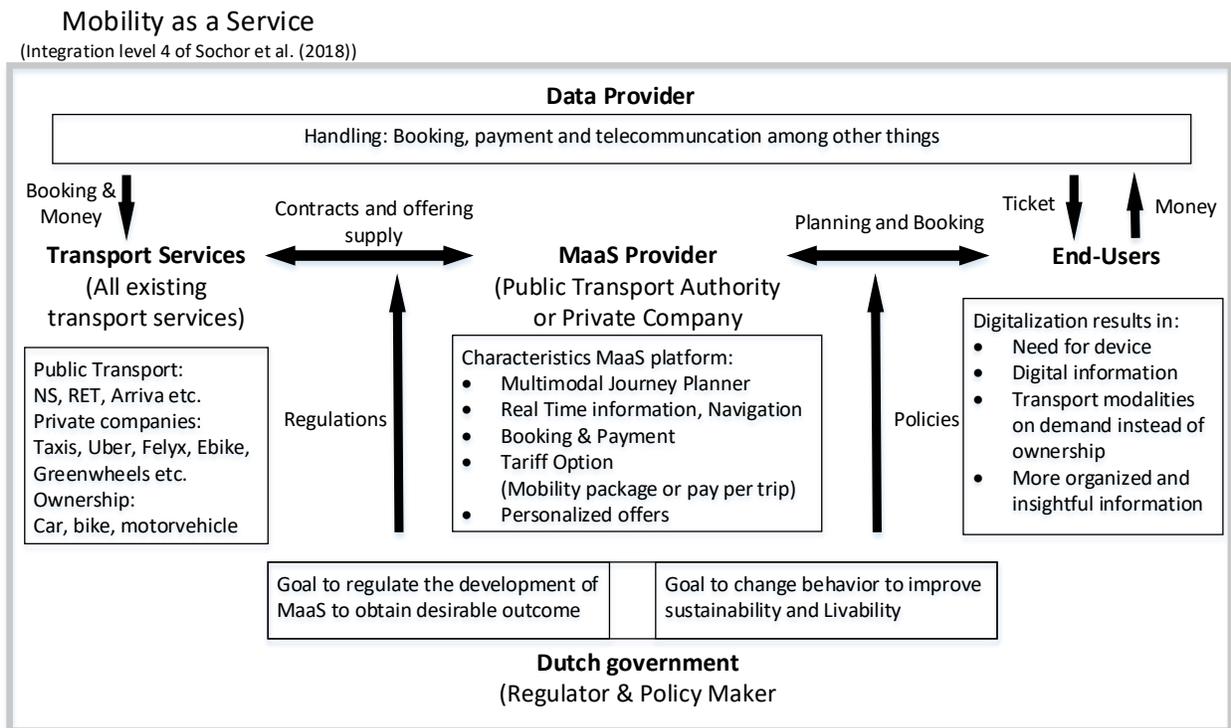


Figure 0.1: The demarcation of the considered MaaS concept for this research

Even though the MaaS sympathizers claim an improvement for the travelers regarding the mobility services, the need for a device will increase the digitalization of the transport sector. Pangbourne et al. (2018) pointed out that the digitalization could lead to transport related social exclusion. Nevertheless, the MaaS Alliance (2019a) claimed that the introduction of MaaS will contribute to a more inclusive transport system. If an individual is unable to participate in society up to the society's normal standards whether in economic, social, cultural or political arenas due to a lack of mobility, the individual is considered transport related socially excluded to a certain extent (Kenyon et al., 2002). Besides, the introduction of a new mobility concept having an impact on all Dutch citizens will result in changes in the transport system, which requires appropriate and effective governance of the Dutch government to ensure an inclusive transport system (Karlsson et al., 2017). The inclusiveness of the transport system is considered as a public goal due to the importance of sufficient mobility to participate in social, political and economic activities. To develop an adequate transport system, governance is required in pricing

structures, consumer protection and coverage, with the purpose of enhancing the inclusivity of the transport system (Pangbourne et al., 2018).

Thus, both the effects of MaaS on transport related social exclusion as well as the most effective governance to ensure an inclusive transport system, a goal of the government, are undetermined. Therefore, to examine the relation between Mobility as a Service and transport related social exclusion and its implications for the Dutch government the following two research question were formulated:

1) To what extent will the introduction of Mobility as a Service result in transport related social exclusion?

2) How could the government steer the development of Mobility as a Service in order to overcome transport related social exclusion?

The goal of this research was to add scientific knowledge about the effects of MaaS on transport related social exclusion for the Dutch society to the existing knowledge of MaaS. An exploratory research approach was used to explore the effects of the introduction of MaaS on transport related social exclusion. Theory needs to be developed due to the fact that MaaS is a relatively new mobility concept resulting in lack of data. The aim of the first research question was to create a conceptual framework consisting of all the effects of MaaS on the barriers resulting in transport related social exclusion. Using this conceptual framework, the goal of the second research question was formulated as providing an exploratory opinion, which will contribute to effective policy making.

Research Methods

In order to answer the first research question the available literature was thoroughly reviewed in order to derive the barriers resulting in a certain degree of transport related social exclusion and the effects of MaaS on transport related social exclusion. Hereafter, in-depth semi-structured interviews were conducted with six experts – with specific knowledge about either MaaS or transport related social exclusion – and one experience expert – an elderly with a higher risk on transport related social exclusion according to the indicator of CBS/PBL (Kampert et al., 2019). The use of both primary data and secondary data resulted in a nuanced conceptual framework on the basis of both optimists' and pessimists' views regarding the MaaS concept.

For the second research question potential powerful policy ideas were identified through analyzing the obtained data using the in-depth interviews. In order to substantiate the policy ideas of the seven interviewees, document analysis was performed. Even though an exploratory approach was used and the empirical evidence was limited, this exploratory advice can be useful for the Dutch government to establish a better informed debate.

Results of first research question: Effects of MaaS on transport related social exclusion

The effects of MaaS on transport related social exclusion were derived from literature and the interviews. On the one hand, the literature suggested mostly diminishing effects of MaaS on the potential exclusionary factors. This implicates that MaaS will result in improved accessibility for the Dutch citizens. On the other hand, the interviewees were less optimistic about the effects of MaaS on the inclusiveness of the transport system, which implicates that MaaS will result in reduced accessibility and a higher risk on transport related social exclusion.

AGREEMENT BETWEEN REVIEWED LITERATURE AND INTERVIEWEES

The literature and interviewees agreed on the effects of the digitalization as a result of the introduction of MaaS. The digitalization of the transport system improves the provision of digital information in a more organized and insightful manner. However, a significant part of the population – two million people experience difficulties due to digitalization of the Dutch society – lacks the resources and ability to access this digital MaaS platform deepening the barriers for this group. In addition, the interviewees mentioned that to use the digital platform the end-user has to fill in personal information such as their credit card details, which requires an amount of trust in the digital platform. For some people the deliverance of such information might pose a barrier to making use of this new mobility concept. In short, the digitalization of the transport system potentially deepens three barriers and diminishes one barrier (Table: 0.1: Row 2).

DISAGREEMENT BETWEEN REVIEWED LITERATURE AND INTERVIEWEES

Both the literature and the interviewees suggested an impact on the costs of transport. However, both suggested the complete opposite. At an early stage the interviewees are most probably right, suggesting that the costs of transport will increase. An intermediary – MaaS provider – has to make profit, which in the early stage must be paid by the end-users. In a later phase MaaS might result in cheaper transport as suggested in the reviewed literature due to the bulk negotiations and the underlying assumption of MaaS to enable economies of scale (Table: 0.1: Row 4). In this research the effect at the early stage – costs of transport increases – is accepted, because the development of MaaS has not yet begun and the further development is extremely uncertain (Table: 0.1: Row 3).

Besides these two impacts, the literature suggested two positive impacts. However, it was highly doubted by the interviewees that these two impacts will actually affect the individuals with a higher risk on transport related social exclusion. The change from the existing ownership based transport system towards an access-based is considered to be only beneficial for the part of the population that already has sufficient accessibility and sufficient budget, because eventually the costs of shared cars are relatively higher than a privately owned transport modality (Table: 0.1: Row 5). Besides, the suggested improvement in rural areas was questioned, because it is unlikely according to the knowledge of the interviewees that the MaaS provider will invest in less profitable or even loss-making rural areas, while the MaaS provider's primary interest lies in the profits (Table: 0.1: Row 6).

SCHEMATIC REPRESENTATION OF MAAS ON POTENTIAL EXCLUSIONARY FACTORS

The impacts and its related effects on the potential exclusionary factors are schematically represented in figure 0.2. If an individual encounters a barrier, the individual will experience reduced accessibility, which increases the risk on transport related social exclusion. Whether an individual is to a certain extent transport related socially excluded depends on an individual's participation in society. A red line in figure 0.2 represents a deepening effect on the particular potential exclusionary factor, while a green line represents a diminishing effect. The effects of the improved offerings in rural areas are dotted due to the fact that this effect can only be obtained through effective governance. At last, the black lines represent an effect that is considered to be beneficial only for the population that already has sufficient accessibility instead of the population that lacks accessibility, because the interviewees concluded that shared mobility is more expensive posing a barrier to making use of the on-demand transport modalities.

Table 0.1: The substantiation whether the impact is considered and to whether the impact has a diminishing or deepening effect

Impact	Literature or Interviews	Diminishing or Deepening effect	Substantiation whether the impact is considered plausible to have an effect on one or more of the uncovered potential exclusionary factors.
Digitalization	<i>Both</i>	<i>Predominantly Deepening effects</i>	Plausible <i>A significant part of the population lacks the resources and ability to access this digital MaaS platform. Even though, this digitalization of the transport system will improve the digital information provision, it will deepen the barriers for individuals lacking digital skills and a working smartphone. Moreover, end-users have to fill in personal information such as their credit card details, which requires an amount of trust in the digital platform posing barrier to make use of this new mobility concept.</i>
More expensive mobility	<i>Interviews</i>	<i>Deepening effects</i>	Plausible <i>MaaS at an early stage will result in increased costs, because an intermediary, the MaaS provider, has to make profit at the start. Thus, at the early stage the introduction of MaaS will have a deepening effect on the potential exclusionary factor of the financial dimension resulting in reduced accessibility for the population without adequate financial resources.</i>
More affordable mobility	<i>Literature</i>	<i>Diminishing effects</i>	Implausible <i>Only at a later stage the suggested negotiation in the literature about prices as a result of the purchase of bulk trips might lead to reduced costs.</i>
Improved offerings rural areas	<i>Literature</i>	<i>Diminishing effects</i>	Plausible subject to effective governance <i>In the literature MaaS was suggested to have a positive effect on the offerings of rural areas. Nevertheless, the interviewees indicated that governance is essential in order to achieve this positive effect due to the fact that the MaaS provider's primary interest lies in the profits, which are suggested to be lower or even loss-making in the low-density areas.</i>
Access-based transport system	<i>Literature</i>	<i>Diminishing effects</i>	Plausible subject to costs of shared cars <i>MaaS will reduce car ownership and replace it with shared cars or other mobility options. However, the costs of a shared car are relatively high, which implicates that only the people with sufficient transport budget can afford a shared car. Therefore, the change from an ownership-based transport towards an access-based one will be most probably beneficial for the part of the population that already has sufficient accessibility to participate in the Dutch society instead of improved access to a car for the individuals with a higher risk on transport related social exclusion.</i>

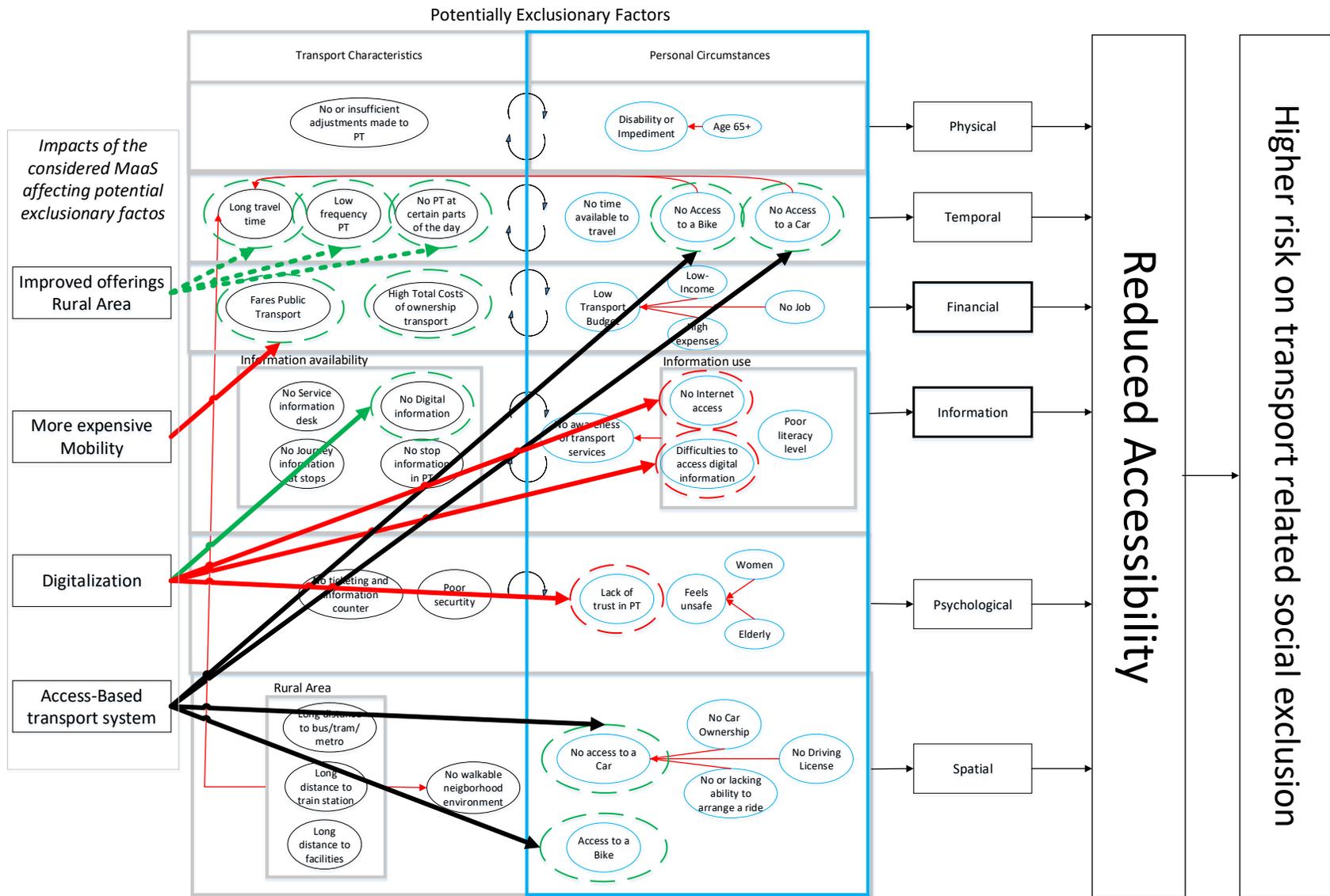


Figure 0.2: Effects of MaaS on the potential exclusionary factors resulting in a higher risk on transport related social exclusion based on literature review and conducted interviews

Results of second research question: Proposed policy ideas

It was recommended by the interviewees for the government to actively steer the development as legislator and regulator. The following policy ideas were suggested by the interviewees to steer the development of MaaS in a desirable societal outcome:

- I. Create a level playing field for the actors in the core of MaaS – transport operators, MaaS providers and Data provider.
 - The regulations need to be the same as for example for traditional taxis and transport network companies such as Uber.
- II. Use the extra available data as a result of MaaS to improve Dutch mobility policy.
 - A learning center making it possible to learn from Dutch citizen's travel behavior.
- III. Align goals of core actors of MaaS and the government in order to obtain desirable outcomes
 - For example a shared car service is only allowed to place their cars in urban areas, if the company will also place a certain number of cars in rural areas.
- IV. Adjust design of digital platforms in order to ensure access for as many people as possible
 - For example making a call service mandatory for every MaaS platform in order to help people with difficulties in accessing digital platforms.
- V. Keep the traditional transport system operational.
 - 2.5 Million People encounter difficulties with the digitalization in the Dutch society (Ministry of the Interior and Kingdom Relations, 2018). Thus, it may be essential for a part of this group to keep the traditional system operational to meet their mobility needs.

Discussion on results

Only about one impact – digitalization – there was agreement between the reviewed literature and conducted interviews regardless the differences in underlying assumptions. On top of that, it is believed by the author that the digitalization of the transport system is inevitable. Even though MaaS might not be implemented to the fullest extent, the further digitalization of the transport sector will pose certain barriers for a significant part of the population. Therefore, it is of great importance to start the debate about the social and moral impacts of the introduction of a new mobility concept in order to prevent an increase of social inequity in the transport sector.

Further research

This research provided better insight in the potential effects of MaaS on transport related social exclusion and proposed policy ideas. However, the conclusions were drawn on basis of limited empirical evidence. As a result of the complexity of the research area and the importance of knowing the impacts of the introduction of MaaS, the following recommendations are made:

- I. Quantify the size of the groups affected by the impacts of the introduction of MaaS.
 - The size of the different groups that encounter the same barrier needs to be examined in order to quantify the effect of MaaS. Hereby the government will be able to invest their limited budget in the most promising adjustments and policies.
- II. Evaluate the potential of the sharing economy to facilitate lower incomes the access to a car.
 - The effects of shared cars for higher incomes are researched, but whether the shared car increases the accessibility for lower incomes is uncertain.
- III. Analyze MaaS pilots focusing on rural areas – Pilot Groningen-Drenthe and Pilot Twente – to determine the potential of MaaS in rural areas to contribute to a more inclusive transport system.
 - Other MaaS pilots focus on the urban areas due to the potential higher profits, while the population living in rural areas are the ones suffering from lower accessibility.

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Geen gegevens voor lijst met afbeeldingen gevonden.

1. Introduction

In 2015 the United Nations developed 17 Sustainable Development Goals. These Goals and their corresponding 167 targets must result in a better world in 2030. One of the 17 Sustainable Development Goals is to create and maintain sustainable cities and communities (United Nations, 2017). At this moment, as a result of the more than 4 million movements carried out by the Dutch citizens every day using their own cars, bikes or any other offered mode of transportation, the roads clog up (CBS, 2019a). The costs of the congestion were estimated at 4.3 billion in 2018 for the Dutch society (Netherlands Institute for Transport Policy Analysis, 2019). Consequently, the mobility of the Dutch society will decrease.

Mobility is of great importance for economic prosperity. Reliable and accessible infrastructure is indispensable for a country to enhance economic activity (Cervero, 2009). Therefore, to meet one of the 167 targets, decent work and economic growth, the factor mobility needs special attention. Increasing the mobility will have a positive effect on both the 'sustainable cities and communities goal' and the 'decent work and economic growth target'.

With the aim of maintaining or even improving the mobility of the Dutch society, innovations in the passenger transport sector are required (Ministry of Infrastructure and Water Management, 2019). These transport innovations should contribute to a sustainable, resilient and accessible infrastructure for everyone, thus leading to increased mobility (Cervero, 2009). In recent years new innovative transport companies such as Uber and Green wheels changed the traditional transport system. These innovative companies offered customers immediate access to goods and services using their digital marketplaces, the on-demand phenomenon. As a result of the increasing on-demand economy the amount of cars can be reduced, which will have a positive impact on the sustainability and livability of the cities (Kruyswijk, 2019) (Jittrapirom et al., 2017). Ownership of a car or any other transport mode is no longer necessary, because people will make use of shared transport modes.

According to the Ministry of Infrastructure and Water Management one of the potential powerful innovations that might make full advantage of both the on-demand transport services and the traditional transport services is Mobility as a Service (MaaS) (Ministry of Infrastructure and Water Management, 2017). The exact definition of MaaS is continually evolving since Hietanen in 2014 envisioned the MaaS definition. "MaaS is a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider" (Hietanen, 2014, p. 2). As starting point for this research MaaS Alliance's definition will be used. According to them, "Mobility as a Service (MaaS) is the integration of various forms of transport services into a single mobility service accessible on demand" (MaaS Alliance, 2019b). If social goals are integrated in the platform, MaaS will contribute to the livability and sustainability of the related areas (Sochor et al., 2018). The Dutch government could meet the mobility needs of the Dutch society in a sustainable, affordable and user's flexible manner by the introduction of MaaS (MaaS Alliance, 2019a).

MaaS Global claims to be the first true MaaS operator and is operational only since 2016 in Helsinki (Whimapp, 2015). Therefore, the amount of extensively analyzed MaaS platforms or pilots is still limited (Smith et al., 2018). Due to the relatively limited knowledge about this mobility concept the Ministry of Infrastructure and Water Management requested examination of the potential social impacts of the introduction of the innovative phenomenon, Mobility as a Service, to discover the potential opportunities and threats of MaaS (Ministry of Infrastructure and Water Management, 2017).

One of the main societal implications of a successful MaaS implementation according to Utriainen & Pöllänen is that MaaS can contribute to a decrease of privately owned cars. This expected result will increase the use of sustainable transport modes, which will contribute to a more sustainable world (Sochor et al., 2015; Utriainen & Pöllänen, 2018). Next to this implication, Karlsson et al. (2016) discovered an increase of pre-trip planning due to the introduction of MaaS.

1.1 Scientific Knowledge Gap

Nevertheless, some implications of the introduction of MaaS have not been thoroughly analyzed or lack agreement among the researchers. One goal of the Dutch government is to have an inclusive transport system (Ministry of Infrastructure and Water Management, 2019). An inclusive transport system means that every individual is able to participate in economic, political and social life of the community (Kenyon et al., 2002). One of the implications of the introduction of MaaS would be the need for a device to connect with the MaaS provider, because the service package provided by the provider, mobility, can only be purchased by using a phone or any other digital device, which needs to be connected with the MaaS platform (Li & Voegelé, 2017). Lyons et al. (2019) suggested that the need of a device will result in digitalization of the transport sector as a result of the introduction of MaaS. Pangbourne et al. (2018) suggested that the digitalization of the transport system could lead to transport related social exclusion. However, MaaS Alliance (2019a), suggested that the introduction of MaaS could contribute to a more inclusive mobility system. Besides, the new mobility concept will result in regime changes within the transport system and thus requires changes to governance and regulations (Karlsson et al., 2017). To develop an adequate transport system, governance is required in pricing structures, consumer protection and coverage, with the purpose of enhancing the inclusivity of the transport system (Pangbourne et al., 2018).

In conclusion, the effects of the introduction of Mobility as a Service on transport related social exclusion both negative and positive are unknown at the moment. Therefore the goal of this research is to fill this scientific knowledge gap.

1.2 Research Goal, Research Question and Sub-questions

The introduction of MaaS will affect the inclusivity of the transport system either positively or negatively. The goal of this research is to uncover the effects of MaaS on the posed barriers of accessibility of an individual to participate in society. For example, the digitalization is suggested to result in transport related social exclusion according to Pangbourne et al. (2018), while MaaS alliance (2019) suggests that the on demand aspect of Mobility as a Service will take away current posed barriers resulting in transport related social inclusion. Therefore, to examine the relation between Mobility as a Service and transport related social exclusion and its implications for the Dutch government the following two research question are formulated:

- 1) To what extent will the introduction of Mobility as a Service result in transport related social exclusion?
- 2) How could the government steer the development of Mobility as a Service in order to overcome transport related social exclusion?

For the first research question sub-questions are formulated in order to help answering this research question. The first sub-question focuses on clarifying the key concept transport related social exclusion.

After determining underlying factors of the key concept transport related social exclusion, the sub-question two explores the effects of MaaS on transport related social exclusion:

Sub-questions of the first research question:

- 1) What are the barriers resulting in a higher risk on transport related social exclusion?
- 2) How are the barriers that explain transport related social exclusion affected by the introduction of Mobility as a Service?

The aim of the second research question is to provide an exploratory opinion at an early stage on the inclusiveness of the transport system as a result of the introduction of MaaS. An inclusive transport system is considered a public goal. For that reason it can be emphasized that governance needs to be developed regarding MaaS in order to ensure an improved inclusive transport system. Within the methodology section, chapter 2, the sub-questions of the first research question and the second research question are linked to the methods used for this research.

1.3 Societal Relevance

Researching this knowledge gap will be of both scientific and societal relevance. Filling the identified knowledge gap indicates the scientific relevance of this research. This research will add specific scientific knowledge to the overall knowledge about the Mobility as a Service phenomenon. Moreover, the effects of MaaS on transport related social exclusion are of great interest for the policy makers, the Dutch government. In order to achieve one of their 2040 mobility goals, an inclusive transport system and contribution to the UN's Sustainable Development Goals (Ministry of Infrastructure and Water Management, 2019; United Nations, 2017). The identification of the opportunities and threats of MaaS regarding transport related social exclusion at an early stage will contribute to effective policy making. Therefore, the results of the qualitative analysis, the scientific contribution of this research, will be used to formulate an exploratory policy advice regarding the prerequisites enabling MaaS to contribute to the inclusivity of the transport system.

1.4 Research Approach

To answer the research questions and fill the identified knowledge gap an exploratory research approach is used to explore the effects of the introduction of MaaS on transport related social exclusion. An exploratory approach is chosen based on the following reasons. The research aims at revealing the effects of a new (mobility) concept, for which an exploratory approach is appropriate (Pujianto & Tjahjono, 2019).

Another reason for the chosen exploratory approach is the lack of data. People who are socially excluded are not fully participating in society. Therefore, it is complicated to reach them. Even if data were available, qualitative research would have been powerful to explore the relatively new concept and set out the direction of the final research design. By using an exploratory approach this relatively new concept and its relation to transport related social exclusion can be explored (Brown, 2006). Theory needs to be developed, which can explain the obtained effects of MaaS on transport related social exclusion. Both secondary research and primary research will be carried out. The secondary research consists of literature research, while the primary research includes semi-structured interviews with experts and an in-depth semi-structured interview with an individual with a higher risk on transport related social exclusion. In the next chapter these proposed research methods will be substantiated and linked to the four sub-questions.

1.4 Scope of the Research

As a result of the limited time for this research, 21 weeks, it is not possible to research both the identification of the different socially excluded people and to research the effects of MaaS on the different identified groups. Therefore, the focus of the research will be on establishing a framework that shows the potential effect of MaaS on transport related social exclusion. The impacts of MaaS on transport social exclusion on the basis of available literature will be validated on the basis of six experts with specific knowledge about the key concepts and one individual with a higher risk on transport related social exclusion, an expert by experience. The identification of the individual will be according to the CBS/PBL's transport poverty indicator (Kampert et al., 2019). The experts and individual with a higher risk on transport related social exclusion will be interviewed in order to conclude about the impacts of MaaS found in the literature. The goal of the research is not to identify the people at risk, but to examine the potential effects of MaaS on the inclusiveness of the transport system. Furthermore, the focus will be on the Dutch transport system. Despite the numerous mobility services, transport disadvantage or social disadvantage result in social exclusion even in the Netherlands (Jorritsma et al., 2018).

1.5 Outline

The structure of the report is visualized in figure 1.1. At first in chapter 2 the chosen research methods used to collect the necessary information and data in order to answer the research question and related sub-questions are described. Hereafter in chapter 3, the theoretical landscape, the two key concepts of this research are reviewed. The demarcation and conceptualization of these two key concepts is of great importance in order to analyze the relationship of these two complex concepts. Chapter 4 elaborates on the conceptualization of transport related social exclusion and provides the potential exclusionary factors resulting in inadequate participation. After that, the effects of MaaS on these potential barriers of accessibility are described in chapter 5 on the basis of literature. All the information combined results in the conceptual framework, which is adjusted and further improved in chapter 6 on the basis of the conducted interviews with both experts with specific knowledge about of the key concepts of this research and one individual with a relative higher risk on transport related social exclusion. In chapter 7 an exploratory advice will be provided to the Dutch government in order to take full advantage of the opportunities of MaaS and mitigate the negative impacts of MaaS for the population with a higher risk on transport related social exclusion and by that contribute to the inclusiveness of the Dutch transport system. At last, in chapter 8 the conclusions of the research and its limitations will be discussed resulting in proposed further research.

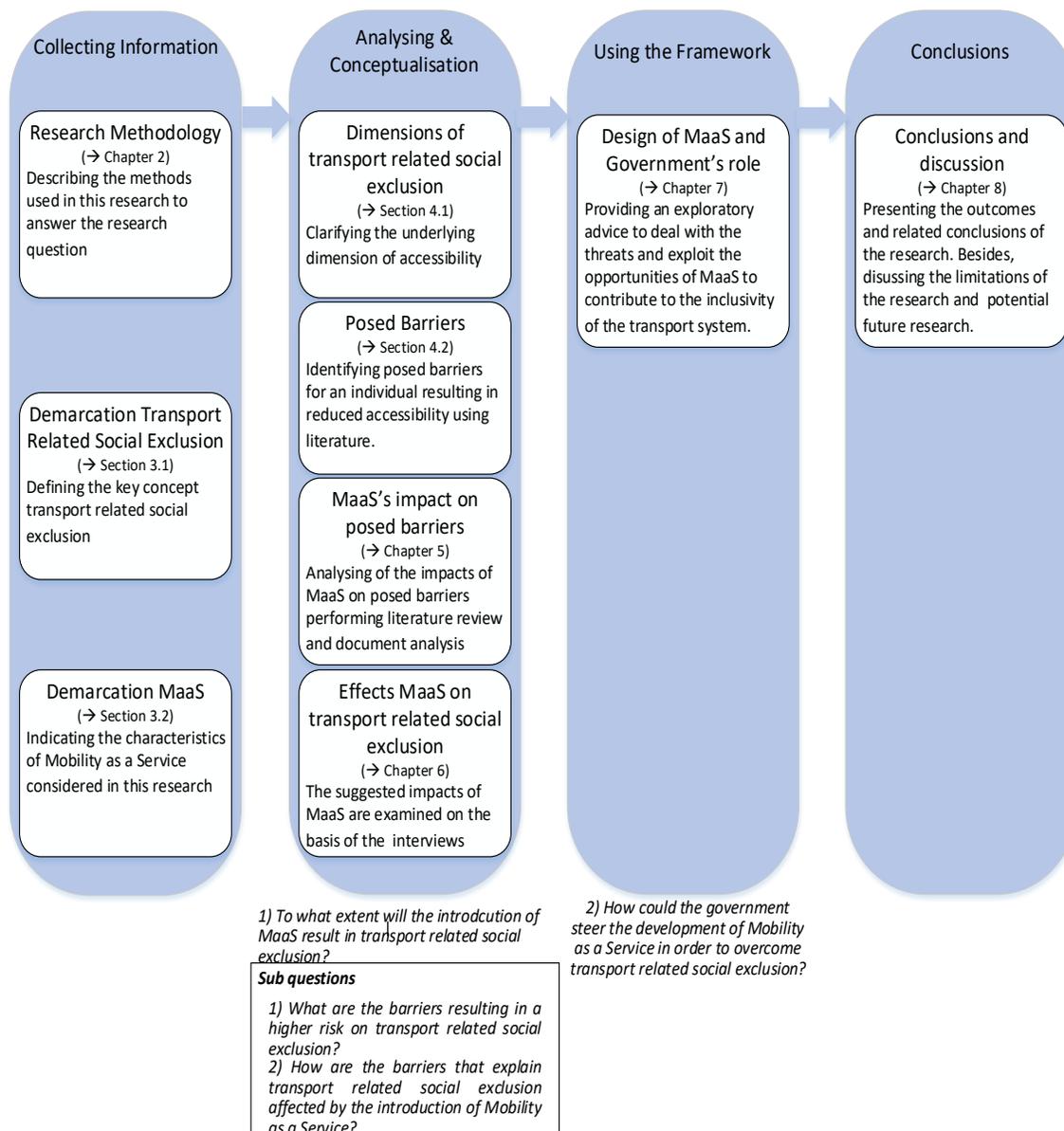


Figure 1.1: Research structure

Collecting Information

Information is gathered through literature review, document analysis and semi-structured interviews with both experts with specific knowledge about the key concepts of this research and an interview with an individual with a higher risk on transport related social exclusion.

2. Research Method

In this chapter the used research methods are introduced. The research methods that were used are related to the chosen research approach. Reviewing available literature and formal qualitative research through interviews are methods that were used to answer the research questions. In the next four subsections the used methods are discussed, taking into account the method limitations, data requirements and the desirable output of the used methods. At first the research methods used to demarcate the key concepts are explained. Hereafter, the research methods used to answer the two sub-questions of the first research question will be substantiated in subsection 2.2 and 2.3, while the used research methods to answer the second research question are emphasized in subsection 2.4.

2.1 Research Methods for Demarcation and Conceptualization Key Concepts

A debate is still going on about the exact definition and specific causes of transport related social exclusion. Therefore, the available literature about transport related social exclusion was thoroughly analyzed using the definition of Kenyon et al. as a starting point in section 3.1: “The process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks, due in whole or in part to insufficient mobility in a society and environment built around the assumption of high mobility (Kenyon et al., 2002, p. 210).” A literature review resulted in a clear demarcation and conceptualization of what is exactly understood by the concept of transport related social exclusion within this research. Both google scholar and the TU Delft library were consulted using the search term “Social Exclusion” AND “Transport”. Further, the snowballing technique was used to gather the essential information in order to analyze the concept within the limited time. On top of that, Anne Durand, an employee of the Netherlands Institute for Transport Policy Analysis (KiM) researching transport related social exclusion, provided documents of KiM researching the same field.

The same applies for the other key concept, Mobility as a Service. MaaS has not yet become widespread and researchers have not reached consensus about what exactly encloses MaaS. In order to demarcate what is understood exactly by MaaS in this research, literature about the different definitions were reviewed in Appendix A and shortly discussed in section 3.2. Again the TU Delft library and google scholar were consulted, using the search term “Mobility as a Service” AND “Definition” in order to uncover the characteristics of MaaS. The MaaS alliance definition was used as starting point within the identification of what is understood by MaaS within this research: “Mobility as a Service (MaaS) is the integration of various forms of transport services into a single mobility service accessible on demand” (MaaS Alliance, 2019b). The aim of this demarcation was to define what is understood by MaaS for this particular research instead of providing a perfect definition of MaaS. The most extreme form of MaaS, the integration of all characteristics, was considered in order to uncover all the potential effects of MaaS on potential exclusionary factors. If only a few of the characteristics were analyzed, a potential threat or opportunity of MaaS would have been overlooked.

The demarcations of both Transport related social exclusion and Mobility as a Service resulted in a conceptualization of these key concepts. The conceptualizations were used in the next chapters to help answering the research questions.

2.2 Research Methods for First Sub-question of First Research Question

The first sub-question was formulated to create a framework consisting of the relevant factors that influence the risk of transport related social exclusion. This sub-question will be answered in chapter 4. Multiple researchers have made a similar framework about the causes of transport related social exclusion. Therefore, literature review, using the search term “Transport” AND “Social Exclusion” AND (“Factors” OR “Barrier”), was a powerful tool to gather potential exclusionary factors resulting in transport related social exclusion. The gathered data resulted in a proposed framework considering all the factors that have a plausible impact on transport related social exclusion. However, the inter-relationship of the factors had to be analyzed in order to be able to indicate overlapping factors and combine or cluster the factors at an early stage (Kampert et al., 2019).

Besides literature review, another research method was used, an in-depth semi-structured interview with expert Astrid Kampert. Astrid Kampert, statistical researcher for CBS, composed an indicator of the risk on transport poverty. In order to create the indicator, she had to combine several measurable factors that affect transport related social exclusion. The expert was interviewed to validate the proposed potential exclusionary factors based on the literature review.

Research Method	Desk research: Literature review (Research term: “Transport” AND “Social Exclusion” AND (“Factor” OR “Barrier”) , using snowballing technique) Document analysis Formal qualitative research: Semi-structured interviews: Astrid Kampert
Method Limitations	Literature review is biased through the assessed literature. According to Boell & Cezec-Kecmanovic literature review can be better described as a hermeneutic process. Thus, a literature review is biased through the interpretation of the researcher performing the literature review (Boell & Cezec-Kecmanovic, 2011). Next to the literature review, policy documents were taken into account in order to define transport related social exclusion and its causes, making use of the fact that the objective of the government is to create an inclusive transport system. Therefore, the policy documents can contain important information about the causes resulting in transport related social exclusion according to the government. However, document analysis should be seen as a complementary research method, because policy documents are not created for the purpose of research. Therefore, the policy documents are probably not detailed enough to answer the sub-question adequately (Bowen, 2009). The semi-structured interview was used as an additional source to gather data. However, due to the lack of time the data might be incomplete and as a result of a lack of trust in the interviewer the obtained data might not be entirely reliable (Myers & Newman, 2007). For that reason, the interviews were planned well in advance and well prepared as much as possible in order to obtain complete and reliable data complementary or equivalent with the literature review.
Data input (Frameworks, Used Literature)	The definition of transport related social exclusion of Kenyon et al. (2002), was used as input for this sub-question. The distinction between the risk of being in transport poverty and actually being transport socially excluded is of great importance (Levitas, 2005). In the framework the factors that increase the risk on transport related social exclusion were examined. The transport related social exclusion indicator of CBS/PBL and the conceptual framework of Lucas were useful input to

	discover the different potential exclusionary factors (Kampert & Dahlmans, 2018; Kampert et al., 2019; Lucas, 2012).
Output	This first sub-question resulted in a clear framework with the identified factors that affect the risk of transport poverty directly and transport related social exclusion indirectly in chapter 4.

2.3 Research Methods for Second Sub-question of First Research Question

The goal of this sub-question, presented in chapter 5 and 6, is to clarify the effects of the relatively new mobility concept Mobility as a Service. More precisely, the expected impacts of the introduction of MaaS on the potential exclusionary factors were researched. At first a literature review was performed in order to uncover the effects of the impacts of MaaS on the basis of literature presented in chapter 5. Hereafter in chapter 6, the impacts of MaaS on the basis of in-depth semi-structured interviews are used to improve the conceptual framework consisting of the effects of MaaS on transport related social exclusion.

The executed literature review resulted in a first conceptual framework in chapter 5 consisting of both concepts. The research method used in chapter 5, literature review, had some limitations and required data input:

Research method	Desk research: Literature review (Research term: “Mobility as a Service” AND “Effect”, using snowballing technique)
Data input (Frameworks, Used Literature)	The MaaS congress at March third was an important opportunity to meet experts to discuss what is understood by MaaS. Besides, the available literature was examined. In section 3.2 a literature review about what is understood by MaaS in this research is provided. It can be concluded from this literature review that there is no consensus about the outcomes and implications of the introduction of MaaS yet. The impacts of MaaS were derived from literature and presented in chapter 5
Output	The outcomes of the literature review resulted in a conceptual framework consisting of the effects of MaaS on transport related social exclusion on the basis of solely literature.
Method Limitations	The limitation of this research method is that the effects were suggested by researchers based on their knowledge. Nevertheless, it is the most efficient way, because data about the effects are not available on a large scale at the moment. Therefore, an exploratory research approach was chosen to discover the potential threats and opportunities that need further research in a cost and time efficient manner (Boell & Cezec-Kecmanovic, 2011).

Next to the literature review in-depth semi-structured interviews were conducted in order to verify the effects of MaaS on transport related social exclusion. The group interviewees consisted of seven individuals with specific knowledge about Mobility as a Service or transport related social exclusions. The group of interviewees consisted of six experts and one individual with a high risk on transport related social exclusion according to CBS/PBL’s indicator (Kampert et al., 2019). A full description of the interviewees and the interview questions can be found in appendix B. As a result of the coronavirus the approached

elderly living in a nursing home were no longer contactable to participate in the in-depth interviews. Therefore, only the elderly, who was able to skype was interviewed.

The obtained data is analyzed using R-Studio and the software package RQDA to perform content analysis. The codes were created bottom-up in order to gather as much data as possible. The code labels are biased through the knowledge of the coder. Before conducting the interviews, the checklist of Tong et al. (2007) was verified. Despite the bias of the researcher, this way of analyzing will provide important first insight by the in-depth interviews about the effects of MaaS on the barriers resulting in reduced accessibility. These effects may or may not conflict or correspond with the suggested effects in the literature. The interview outcomes were used to adjust the conceptual framework that was only based on literature in chapter 5. The conceptual framework in chapter 6 is more nuanced, because both optimists and pessimists regarding the MaaS concept were interviewed. However, also the gathered primary data through interviews had limitations:

Research method	Formal qualitative research: Semi structured in depth interviews: An expert by experience and experts about transport related socially excluded people.
Data input (Frameworks, Used Literature)	The first part of this sub-question, the conceptual framework on the basis of literature, was input for this sub-question creating the final framework consisting of the two key concepts and their relations. Thematic content analysis was performed in order to analyze the most important impacts of MaaS based on the experience and expertise of the interviewees (Braun et al., 2014). The effects of MaaS derived from literature in the first part of this sub-question, chapter 5, were useful knowledge to analyze and code the empirical data obtained through the semi-structured interviews. The empirical data was used to validate and to adjust the suggested effects of MaaS on transport related social exclusion in the literature.
Output	The outcomes resulted in a proposed framework that gave insight in the effects of MaaS on transport related social exclusion according to the literature and acquired interview data.
Research Limitations	Semi structured in depth interviews were chosen, because reaching potentially socially excluded people by surveys is difficult. According to Bethlehem, conducting in-depth interviews should result in a high return rate, which is important to actually have empirical data of the different experts and not have biased response. The introduction of MaaS will most probably result in digitalization of the transport system according to Pangbourne et al. (2018). For that reason an online survey using digital platforms would have left out the potentially socially excluded due to digitalization (Bethlehem, 2010). The choice for semi-structured in-depth interviews with both experts and one transport related socially excluded individual is insurmountable. Nevertheless this choice for semi-structured interviews resulted in limited empirical evidence, due to the limited conducted interviews.

2.4 Research Methods for Second Research Question

The first research question is the core of this research. In general, exploratory research results in hypotheses instead of testing hypotheses (Sue & Ritter, 2012). Nevertheless, an exploratory opinion leading to a proposed advice can be provided in chapter 7 on the basis of the proposed framework containing the effects of MaaS on the transport related social exclusion. However, the proposed advice needs to be formulated with extreme caution due to the missing generalizable data that support the advice. The interviewees (Appendix B: Table B.1) were questioned about the role of the government and potential powerful policy measures to maintain or even improve the inclusivity of the Dutch transport system as a result of the introduction of MaaS. The proposed advice is intended for the policy makers, Ministry of Infrastructure and Water Management to take full advantage of the opportunities and mitigate the threats of MaaS.

The most important ministry for this particular public goal, an inclusive transport system, is the Ministry of Infrastructure and Water Management. However, besides the Ministry of Infrastructure and Water Management, both the Ministry of Economic Affairs and Climate and the Ministry of Home Affairs and Kingdom Relations are responsible for an equal society. Therefore, in this research the government is used as umbrella to refer to the different Ministries, the legislative authorities, with a certain interest or responsibility regarding the public goal, an inclusive transport system.

Research method	Desk research: Document Analysis (Searching term: “Policy” AND “Mobility”, using snowballing technique. Formal qualitative research: Semi structured in depth interviews: An expert by experience and experts about transport related socially excluded people.
Data input (Frameworks, Used Literature)	The input for this research question is the proposed framework of the first research question. Using this conceptual framework as prior knowledge the data gathered through semi-structured interviews were analyzed in order to obtain possible policy instruments that can be proposed to steer the development of MaaS. Document analysis was performed to substantiate the effectiveness of the proposed policy measures.
Output	An exploratory opinion, advice, for the policy makers, Ministry of Infrastructure and Water Management, to steer the development of MaaS in that way that the ministry can take full advantage of the opportunities and mitigate the threats to maintain or even improve the inclusiveness of the Dutch transport system.
Research Limitations	The proposed framework of the first research question is of course biased through the mentioned limitations in the two related sub-questions. Next to that, document analysis was performed, which is biased by the fact that some documents are not publicly available as a result of sensitive information (Bowen, 2009). However, analyzing policy documents and conducting in-depth semi-structured interviews are a cost-efficient way to discover potential steering policies. The group of interviewees was the same as the group of interviewees for the second sub-question of the first research question (Appendix B).

3. Theoretical Landscape

The two key concepts of this research are respectively transport related social exclusion and Mobility as a Service. For both of these concepts a widely adopted definition is not available yet. For that reason the literature about these two concepts is researched in order to demarcate both of these concepts. The aim of this chapter is not to create a general accepted definition, but to define what is understood by these two concepts within this research. The literature review resulted in a first conceptualization of what the interrelations are of both of these concepts. First in subsection 3.1, the concept transport related social exclusion is thoroughly discussed resulting in a conceptualization of the concept. Thereafter, the conceptualization of the relatively new transport concept, Mobility as a Service, is described in subsection 3.2. The conceptualizations of both of the concepts will be used throughout this research to uncover both the positive and negative impacts of the transport concept, MaaS, on transport related social exclusion.

3.1 Transport Related Social Exclusion

In order to define transport related social exclusion, the concept has to be seen in the bigger picture. Therefore, the comprehensive concept social exclusion needs to be explained at first. Even about the precise definition of social exclusion there is no consensus (Lucas, 2012). In this subsection transport related social exclusion is defined in order to analyze the concept in the next chapters. A demarcation of what is understood by transport related social exclusion in this particular research is provided due to the missing consensus about the precise definition of the concept.

In 2008 more than 120 million people in the European Union were at poverty or social excluded according to the European Commission (2019), which emphasizes the need of research regarding the social exclusion concept. The European Commission uses the social exclusion concept and poverty concept interchangeably (European Commission, 2019). For that reason the distinction between both of the phenomena are emphasized in subsection 3.1.1 in order to clarify what is meant by the social exclusion concept in this research. Hereafter, the dimensions of the multidimensional social exclusion concept are discussed in subsection 3.1.2. In this research the focus is on transport related social exclusion, one of the dimensions of social exclusion. The detailed introduction of the key concept, transport related social exclusion, can be found in subsection 3.1.3. At last, in subsection 3.1.4 a small conclusive framework is presented combining the information of the first three subsections.

3.1.1 Distinction Social Exclusion and Poverty

The concepts social exclusion and poverty are strongly linked. Both of the phenomena are used to raise awareness about the inequalities within a geographical region (Madanipour et al., 2015). According to Levitas (2005) a distinction between social exclusion and poverty is necessary in order to analyze one of the concepts. Poverty is generally linked to a person's resources, while social exclusion focuses on the position of the person within the society (Spicker, 1996). Poverty is used to underline the economic deprivation and point out the unequal distribution of resources within a country (Madanipour et al., 2015). Next to that it is a static evaluation, because the focus of the concept is mainly on the resources instead of the abilities of an individual to be part of society. An individual is in poverty if the individual has a disadvantage on one of the poverty indicators (European Commission, 2019).

An individual can feel excluded as a result of multiple causes, which may have different consequences for the individual (Kenyon, 2003). Both the causes and consequences can be both material and non-material

for the social exclusion concept. Contrary to the poverty concept the social exclusion is suggested to be a dynamic process (Hine & Mitchell, 2001). An individual is socially included if the individual is able to participate in the activities in the same way as other citizens living in the same society (Hine & Mitchell, 2001). This in contrast to the social excluded citizens, who are losing connection with society, institutions and powerful groups as a result of the lack of participation in society (Social and Transport Research Services, 2000).

An important notion is that a person is socially excluded if he or she has a desire to belong to that society, but is not able to do so as a result of barriers encountered by that individual (McCluskey, 1997). Even though several potentially exclusionary factors estimate a high risk on social exclusion for an individual, the particular individual can feel included (Currie, 2010). Obviously, the reasoning applies also for an individual with an assessed low risk on social exclusion, who can still feel excluded. Therefore, in this research the aim is to elaborate on the risk of social exclusion for a group with certain characteristics instead of claiming that a particular individual is socially excluded and minimize or even remove the factors that cause social exclusion for that individual.

According to Schwanen et al. (2015) social exclusion is characterized by interminable levels of social inclusion or social exclusion instead of a binary state. The level of social inclusion or exclusion is indicated by the potentially exclusionary factors influencing the different dimensions of social exclusion (Peace, 2001). The fact that social exclusion is not determinable by just analyzing the disadvantages of an individual, amplifies the need of researching the social exclusion concept in depth considering the different potentially exclusionary factors. For example, an individual might not feel safe using the public transport, while another individual living in the same household does not feel that way. This shows that feelings cannot be expressed in disadvantages.

Even though this subsection aims to clarify the distinction between both concepts, Madanipour et al. (2015) suggested that both concepts have overlapping elements. Both the concept of poverty and social exclusion aim to support policy makers in creating policies, which will lead to diminishing of inequalities within the society (European Commission, 2019). Kenyon (2003) even suggested that poverty is a contributory factor, a dimension of social exclusion, which might negatively influence an individual's risk on social inclusion. Despite the overlapping elements, social exclusion includes relational issues next to the distributional issues considered in the poverty concept. Lucas concluded in (Lucas, 2012) that the researchers agree on the fact that the social exclusion concept is a more multidimensional, multi-layered and a more dynamic concept of deprivation than the poverty concept.

3.1.2 Dimension of Social Exclusion

According to Levitas et al (2007) social exclusion is "the lack or denial of resources, rights, goods and services, and the inability to participate in the normal relationships and activities, available to the majority of people in a society, whether in economic, social, cultural or political arenas" (Levitas et al., 2007, p. 7). Levitas et al. (Levitas et al., 2007) was not the first researcher to indicate different dimensions of social exclusion, called arenas by Levitas et al. Both Percy-Smith (2000) and Kenyon et al. (2002) suggested different dimensions of social exclusion. Despite the different number of dimensions and the different approaches in order to obtain the dimensions some similarities can be discovered (Table 3.1).

Table 3.1: Dimensions of social exclusion:

Dimensions of Social Exclusion		
Kenyon et al. (2002)	Percy-Smith (2000)	Levitas et al. (2007)
Economic	Economic	Economic
Societal	Social	Social
Social Networks	Group	Cultural
Personal	Individual	
Organized Political	Political	Political
Personal Political		
Living space	Neighborhood	
Mobility	Spatial	
Temporal		

The different dimensions represent all a different form of social exclusion (Jaroš, 2017). The political dimension for example indicates an individual's power to influence the policy making process, while the individual, personal and cultural dimensions reflect an individual's opportunities to participate in the activities that are considered normal (Kenyon et al., 2002).

The economic dimension is considered the most accurate to define an individual's risk on social exclusion, because the factors are measurable like the distribution of resources (Jaroš, 2017). The economic dimension of Percy Smith (2000) and Kenyon et al. (2002) represent access to money, which is closely related with the distribution of money among the citizens. It can be argued that the economic dimension resembles the poverty concept the most. Despite the fact that this dimension is considered the easiest to measure, "prioritizing the economic dimension to the neglect of other aspects of social exclusion is problematic in dealing with major social problems" (Madanipour et al., 2015, p. 721)

The spatial and mobility related dimension of social exclusion is ignored in some of the literature (Cass et al., 2005). Levitas et al. (2007) did not consider the spatial related aspects of the social exclusion concept. Nevertheless, both Kenyon et al. (2002) and Percy Smith (2000) included such a dimension and pointed out the importance of including it. Kenyon et al. (2002) even subdivided this dimension in a living space and mobility dimension. Percy Smith's spatial and neighborhood dimensions attempt to capture the same potential exclusionary factors. The mobility dimension reflects the accessibility to transport, while the living space factor includes the factors associated with an individual's local environment (Kenyon et al., 2002). Even though the Dutch transport infrastructure is ranked fourth worldwide, it is essential to consider transport related social exclusion, because even societies with a high level of mobility may have to do with social exclusion (Kampert et al., 2018) (World Economic Forum, 2015). The more mobile a society becomes, the more certain individuals or groups may get disproportionately impacted by the transport system through for example high monetary costs of essential mobility, which will eventually

result in social exclusion (Kenyon, 2003). For example, if the standard of society is to travel every day by car to cover long distances, an individual will have to own a car and pay for the fuel to live up to the standards of the society. As a result of the extra costs of the extra mobility, the particular individual might not be able to pay for all these extra movements and will be disproportionately impacted by the high monetary cost of essential mobility.

3.1.3 Definition Transport Related Social Exclusion

Currie & Stanley (2008) suggested that transport is indispensable in order to achieve social inclusion. Thus, in order to answer the research question – To what extent will the introduction of Mobility as a Service result in transport related social exclusion –, transport related social exclusion needs demarcation to analyze the possible effects of the new mobility phenomenon, Mobility as a Service, on the inclusiveness of the transport system. In this subsection the definition used for this research is discussed and substantiated with the proposed definitions in the literature. In the introduction of this research the definition of Kenyon et al. (2002) was proposed as the starting point in order to define transport related social exclusion due to the fact that several researchers referred to this definition:

“The process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks, due in whole or in part to insufficient mobility in a society and environment built around the assumption of high mobility (Kenyon et al., 2002, p. 210).”

An important conclusion that can be drawn from this definition is that reduced accessibility is the main factor causing transport related social exclusion. Jaroš (2017) agreed with Kenyon et al. (2002) that transport inaccessibility will only be a problem if reduced accessibility results in an actual barrier to prevent adequately participating in the society the individual is geographically citizen of. If reduced accessibility withholds an individual from normal activities for example having a job, it is considered social exclusion (Currie & Stanley, 2008). Besides having a job, social interaction with family and friends are considered normal activities in the western societies. According to Social and Transport Research Services UK a citizen that is socially included has adequate social participation and is socially integrated (Social and Transport Research Services, 2000).

According to Kenyon et al. (2002) accessibility to opportunities, services and social networks is a necessity to make sure people can participate in the economic, political and social life of the community. Accessibility is a measure to indicate the available transport for an individual (Jones, 1989). A reduction in an individual's accessibility might result in not performing a certain trip due to the posed barriers. Accessibility is defined in this research as the ease to reach a destination (Levine & Garb, 2002). Therefore, the suggestion of Jones (1989) that accessibility is a measure of supply, namely potential mobility, is considered suitable to measure the risk of transport related social exclusion. If the supply of potential mobility, accessibility, leads to lack of participation in society, the particular individual is considered transport related socially excluded (Kenyon et al., 2002).

Accessibility is considered the supply of mobility. Consequently, mobility is not the appropriate concept to measure the risk on transport related exclusion, which is illustrated by the following example. If an individual orders his or her goods online, the mobility, the amount of executed trips, decreases, while the accessibility for the particular goods has increased, because the individual could easily secure the goods (Alsnih & Hensher, 2003). Accessibility is more appropriate due to the fact that the individuals not necessarily have to travel to participate in society.

Therefore, reduced accessibility will be used to measure the risk of an individual on transport related social exclusion. Preston & Raje (2007) suggested that an increase in the level of accessibility of an individual may lower the risk of transport related social exclusion. In order to increase the accessibility of the Dutch citizens the barriers and underlying issues causing reduced accessibility need to be exposed and minimized or even removed. The underlying factors and posed barriers of accessibility will be discussed in Chapter 4. It is of great importance to notice that accessibility is only used to measure the risk of transport related social exclusion instead of a measurement to determine whether an individual is socially excluded or not. If an individual feels transport related socially excluded, it is a result of the desire to belong and participate within that society to the normal standard. However, the individual is not able to participate in the society in the way the other citizens of the society are participating.

3.1.4 A Conclusive Framework of Transport Related Social Exclusion

The information obtained from the literature study results in multiple insights about the concept of transport related social exclusion. In figure 3.2 a conclusive framework is presented using the demarcation of the concept of social exclusion and its related dimension transport related social exclusion. Reduced accessibility is suggested as the origin of social exclusion in this conceptual framework and research (Figure 3.2: A). From the literature is concluded that individual accessibility is a necessity in order to be able to perform trips and thus participate in the Dutch society. Therefore accessibility is used to measure the risk for transport related social exclusion. The lower the level of accessibility, measure of the capacity of an individual to reach different locations given the accessibility of their current location, the higher the risk on lack of social interaction, inadequate participation and lack of power (Figure 3.2: B). The risk on these three factors can be explained by the fact that in order to reach activities such as work, friends and family a certain level of mobility is required to reach these key activities. If an individual experiences reduced accessibility, the individual might no longer be able to reach his or her job or social activities resulting in inadequate participation in the society he or she belongs to. Nevertheless, reduced accessibility, the assumed indicator to measure the risk of transport related social exclusion, does not necessarily result in the proposed negative consequences.

Even if an individual has reduced accessibility, higher risk on transport related social exclusion, an individual can still feel included, because the reduced accessibility did not affect his or her ability to reach different locations and thus did not have an effect on the individual's participation in society (Currie, 2010; R Levitas, 2005). Therefore the lines from reduced accessibility to the negative consequences are dotted, because they represent the higher chance of the negative consequences as a result of reduced accessibility (Figure 3.2: B). Whether an individual is considered to be transport related socially excluded can be derived from the flow chart visualized in figure 3.1. If an individual is not able to engage in society up to a society's standard as a result of insufficient capacity to reach the locations resulting in either a lack of social interaction, inadequate participation or a lack of power, the individual will be considered transport related socially excluded to a certain extent.

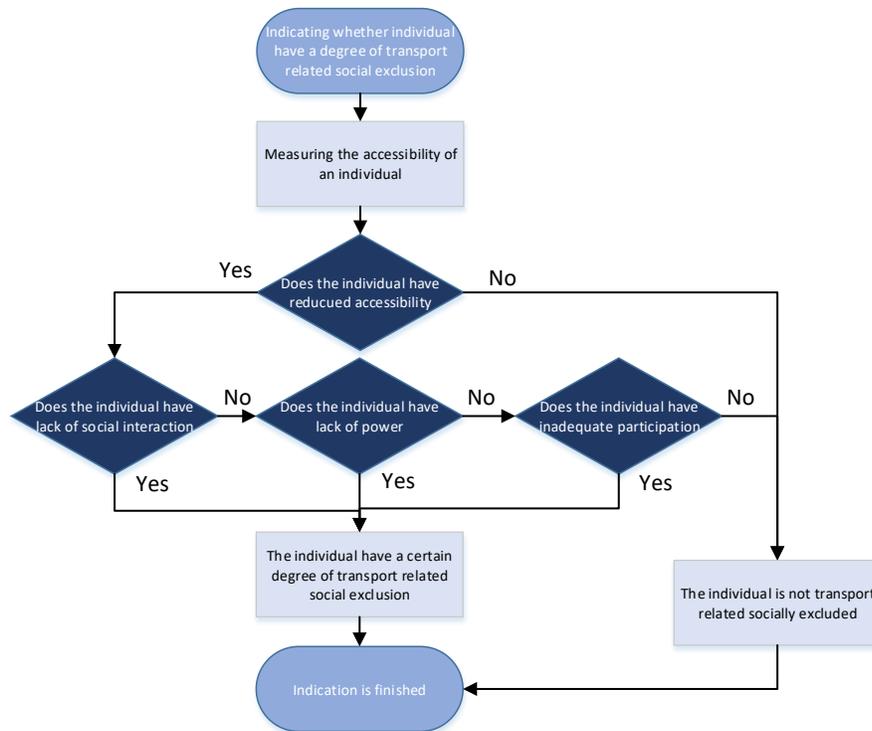


Figure 3.1: Flowchart to indicate whether an individual is transport related socially excluded

If an individual experiences one or more of these negative consequences, the individual is considered to be transport related socially excluded to a certain extent. As stressed out in the previous subsection social exclusion is not a binary state (Figure 3.2: D). On the contrary transport related social exclusion is a dynamic process characterized by endless degrees of transport related social exclusion (Schwanen et al., 2015).

As pointed out in subsection 3.2 the concept of social exclusion consists of different dimensions. In this research the effects of a new mobility concept will be analyzed. For that reason this research focuses on transport related social exclusion in which the economic, cultural, societal and political dimensions of Levitas et al. (2007) are omitted (Figure 3.2: E). However, some underlying potential exclusionary factors of the other dimensions might also pose a barrier for an individual's accessibility, which will be exposed in the next chapter (Litman, 2003). If a person is transport socially excluded, which implies socially excluded, it will affect the well-being of the particular individual (Figure 3.2: F) (Stanley et al., 2011). The aim of this research is to research the effect of a mobility concept. Therefore, even though the dimensions other than the transport related social exclusion dimension are omitted, these dimensions can explain why an individual is socially excluded (Figure 3.2: G).

The demarcation of transport related social exclusion is represented causal and static. However, the social exclusion concept is not as black and white as it is being presented. Nevertheless, the framework provides insight in the concept of social exclusion and clarifies what is understood by the important concepts for this research.

Transport Related Social Exclusion

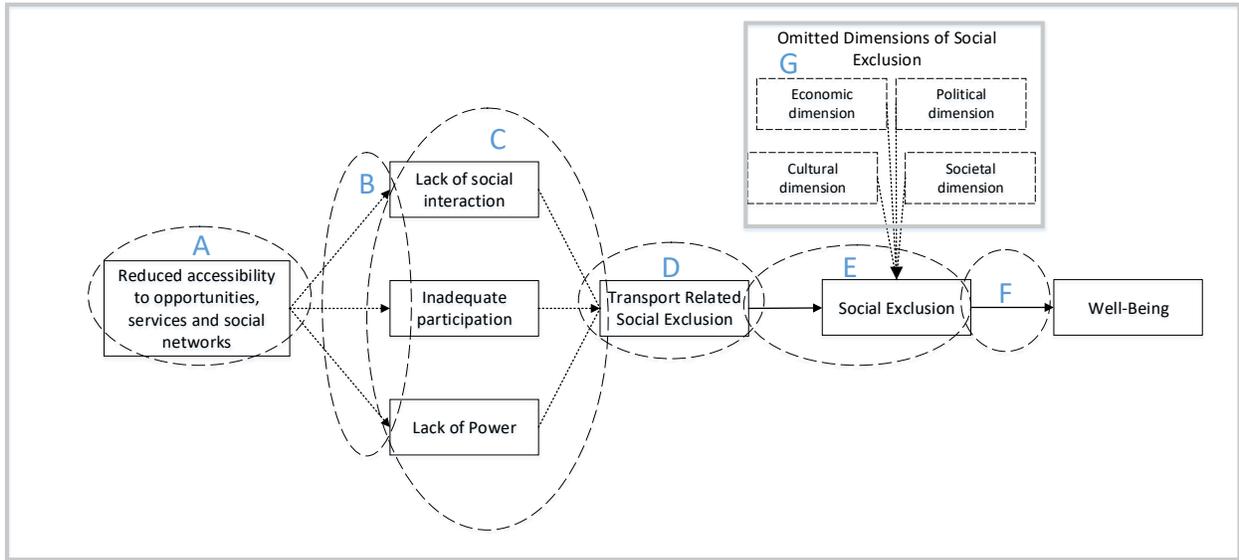


Figure 3.2: Demarcation of the key concept, transport related social exclusion

3.2 Mobility as a Service

This subsection points out the state-of-the-art about Mobility as a Service. In Appendix A an extensive description of Mobility as a Service can be found. In the literature several definitions are provided by different researchers and institutions. In this research six core characteristics are suggested to comprise the concept Mobility as a Service (Appendix A: Section: A.1). First of all Mobility as a Service is a multimodal user-centric digital mobility app. However, MaaS will only be considered a full implementation of MaaS in this research if planning, booking & payment, navigation & information of the multimodal journey are all integrated in the app, which are considered the main elements of MaaS (Kamargianni et al., 2016).

If these core characteristics are integrated in a Mobility as a Service platform, the integration level is at least level three (Smith et al., 2018). However in order to obtain desirable societal outcomes, policy instruments are considered to be powerful (Harms et al., 2018; Smith et al., 2018). Therefore, the highest level of integration, level four, is necessary in this research (Appendix A: Section: A.2). This implies that all the aspects of MaaS, the six core characteristics, are integrated in the Mobility as a Service platform that will be used to analyze the effects of MaaS on transport related social exclusion. In other words, the most elaborate version of Mobility as a Service is analyzed to examine all potential diminishing and deepening effects of MaaS on the potential exclusionary factors influencing the risk on transport related social exclusion.

The core business of the MaaS Business Ecosystem consists of four actors; the MaaS provider, the end-users, all existing transport services and the data provider. The role of the government is still unknown within the MaaS Business Ecosystem, because MaaS has not been implemented yet in the Netherlands. Nevertheless, the Dutch government will have an important role to play regarding a successful implementation of MaaS due to the related public goal, an inclusive transport system. Even though the development of MaaS through a private company could result in advanced and personalized offers for the end-users, it is of great importance that the government either takes an active role by supporting a public transport authority as MaaS provider or actively steers the development of MaaS as legislator (Kamargianni et al., 2018). Otherwise MaaS will not meet its own high expectations related to financial and ecological sustainability (Karjalaibnen, 2017).

The demarcation of the concept Mobility as a Service results in a proposed schematic overview of what is understood by Mobility as a Service in this research (Figure: 3.3). The six core characteristics and the core business of the MaaS Business Ecosystem are represented in figure 3.3. The core characteristics are considered to be part of the MaaS platform. However, one of the characteristics is considered to be a fundamental aspect of the end-users, because of the fact that the MaaS platform is a digital platform. This characteristic is a characteristic of the end-user, because it is essential that an end-user owns a digital device to be able to connect with the MaaS platform and make use of the digital platform (Li & Voegelé, 2017). It is obvious that without that device booking and planning a journey in the MaaS app is impossible.

The user-centric characteristic of Mobility as a Service is not explicitly stated down, but is indicated by the personalized offers as an element of the MaaS platform designed by the MaaS provider. Besides, the personalized offers result in more awareness about the available travel options for the end-users. The arrows from the Dutch government represent regulations and policies on the development and execution of the concept of MaaS leading to desirable outcomes, for example reduced car ownership and improved livability (Utriainen & Pöllänen, 2018). Therefore, it can be concluded that the proposed demarcation is in line with the topology of Sochor et al. (2018) of integration level four, the highest integration level. In

Appendix A a full description of the identification of what is understood as Mobility as a Service in this research is provided.

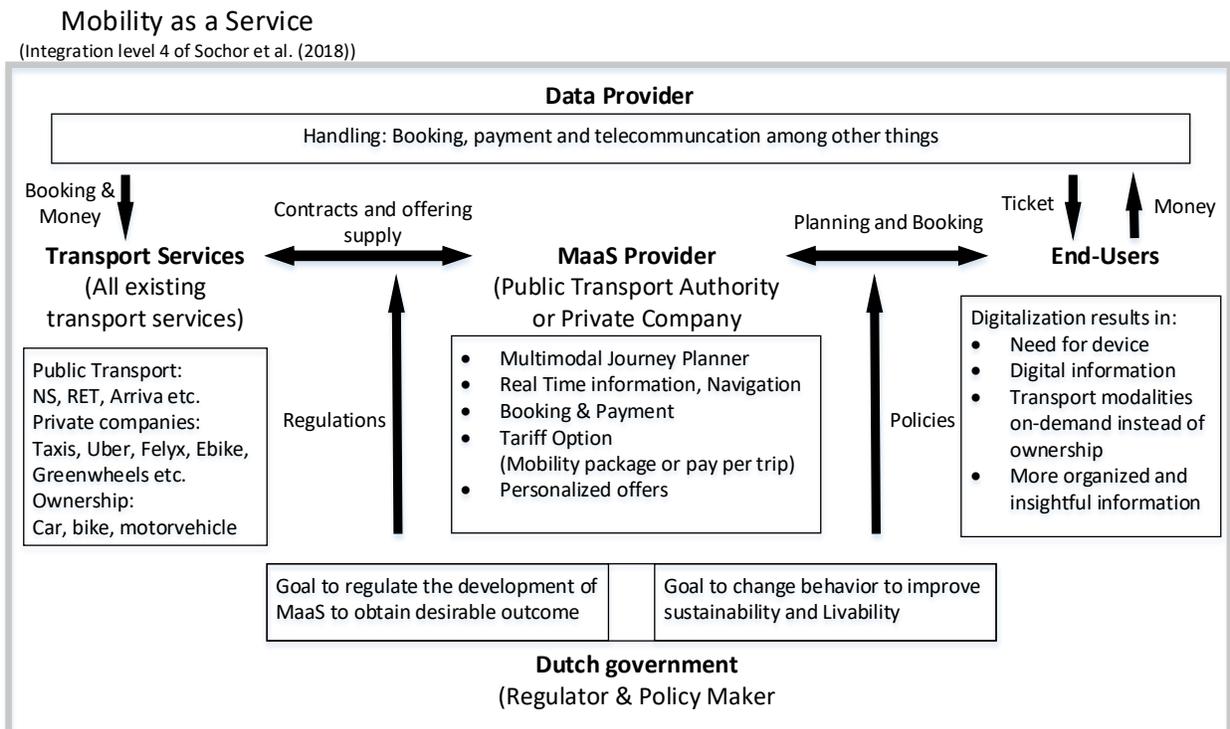


Figure 3.3: Demarcation of the key concept, Mobility as a Service

Conceptualization & Analyzing

A conceptual framework is created clarifying the impacts of MaaS on the potential exclusionary factors resulting in transport related social exclusion by performing a literature review and by conducting semi-structured interviews with both experts and one individual with a higher risk on transport related social exclusion.

4. Identification Potential Exclusionary Factors

In the theoretical landscape the two key concepts of this research are demarcated in order to clarify what is understood with both of these concepts in this particular research. In this chapter the concept transport related social exclusion is conceptualized and analyzed. The aim of this chapter is to convert research ideas into a meaningful framework of the transport related social exclusion concept. The concept is examined in detail in order to explain and interpret the concept. At first the suggested dimensions of transport related social exclusion are discussed and determined in subsection 4.1. Hereafter, the underlying potential exclusionary factors of the dimensions will be indicated in subsection 4.2.

4.1 Dimensions of Transport Related Social Exclusion

In sub-section 3.1 the demarcation of transport related social exclusion was discussed. It was concluded that the risk of transport related social exclusion for an individual can be determined on the basis of that individual's personal accessibility (subsection 3.1). Ignacallo et al. (2016) suggested that accessibility indicators can be of great importance for policy makers to determine the individuals that are at risk to be transport related socially excluded. Before 2015 89 studies with focus on transport related social exclusion had been conducted in Europe (Lodovici et al., 2015). However, in the Netherlands the attention on this particular form of social exclusion has been relatively small with only five studies centralizing the concept of transport related social exclusion. Therefore, to uncover the suggested mechanisms causing transport related social exclusion, literature using a setting other than the Dutch society was also examined, because the dimensions underlying transport related social exclusion are considered to be universal for developed countries. The focus of this sub-section is to determine the mechanisms that result in a higher risk on transport related exclusion: the dimensions of accessibility. First the available literature on the different dimensions is discussed in sub-section 4.1.1. Hereafter the choice of the dimensions, which will be used for this research, is substantiated in sub-section 4.1.2.

4.1.1 Proposed Dimensions of Transport Related Social Exclusion in the Literature

In this sub-section five studies on dimensions of transport related social exclusion are looked into. The studies show differences and they have been carried out in different years over the last decades. Despite the disagreements (Subsection 4.1.1.2), the dimensions proposed in the literature by the different researchers also show several similarities (Subsection 4.1.1.1).

4.1.1.1 Agreement among the Researchers about the Dimensions

The researchers agree on the fact that a certain financial or so-called economic dimension is present (Cass et al., 2005; Church et al., 2000; Halden et al., 2005; Hine & Mitchell, 2001; Yigitcanlar et al., 2019) (Table 4.1.1: Row one). The economic dimension embodies the effect of lacking monetary funds to use the existing transport facilities (Hine & Mitchell, 2001). To reach a destination and by that be able to participate in society requires a certain expenditure (Rashid et al., 2009). Even the time to reach a certain destination can be seen as an expenditure of an individual, because in that same time the individual is not able to work and earn money, commonly named "Value of Travel Time (VTT)" (Athira et al., 2016).

Besides the costs of travel time, the available time and the time of day are also constraints that need to be considered (Rashid et al., 2009) (Table 4.1.1: Row four). For example an individual might have to work while the shops are open and is free while the shops are closed. In this example the individual is not able to go to the shops as a result of the unavailable time of this particular individual. Church et al. (2000) argued that a time-based exclusion is an adequate dimension to represent the "difficulties of organizing

commitments to allow adequate time for travel given network constraints effects” (Church et al., 2000, p. 200). The other researchers agree with the description of Church et al. (2000), but referred to this dimension as the temporal dimension.

The third and last dimension which the researchers fully agree upon, is the need for a physical dimension to represent the underlying mechanisms of transport related social exclusion (Table 4.1.1: Row three). An individual needs to be able to travel independently in order to execute a trip and thus participate in society (Cass et al., 2005). Individuals suffering from a disability are constrained as a result of a society that fails to adjust the transport system in order to ensure full participation. “In the past, such constraints were often described in terms of the individual’s failure to accommodate the built environment, but increasingly the problem is defined as a failure of the built environment to accommodate people” (Litman, 2003, p. 2). Therefore, the distribution of physical constraints corresponds with both the design of the transport system and the abilities of the individual to cope with the physical design of the transport system (Cass et al., 2005).

Table 4.1.1: Agreement among researchers about dimensions of transport related social exclusion

Church (2000)	Hine & Mitchell (2001)	Halden et al. (2005)	Cass et al. (2005)	Yigitcanlar et al. (2019)
Economic exclusion	Economic	<i>Financial</i>	<i>Financial</i>	Economic
Time-based exclusion	<i>Temporal</i>	<i>Temporal</i>	<i>Temporal</i>	<i>Temporal</i>
Physical exclusion	<i>Physical</i>	<i>Physical</i>	<i>Physical</i>	<i>Physical</i>

4.1.1.2 Debate among the Researchers about the Dimensions

On dimensions other than the three described above the five researchers do not completely agree. Cass (2005) did not mention the psychological dimension proposed by Hine & Mitchell (2001) and Yigitcanlar et al. (2019), while Church (2000) and Halden et al. (2005) proposed a similar dimension respectively fear-based exclusion and an environmental dimension, which address the same mechanism (Table 4.1.2: Row one). The dimension refers to the fear or stress an individual experiences as a result of any stage of a certain journey, which prevents an individual from executing a journey (Hine & Mitchell, 2001). Besides, the dimension is about an individual's confidence in the use of the various available transport modalities in order to complete a journey successfully (Yigitcanlar et al., 2019). Cass et al. (2005) made no distinction between physical and psychological impediment, and combined the two dimensions in one physical dimension referring to an individual’s sense of security and confidence in the transport system within the physical dimension.

The spatial dimension was mentioned by three of the researchers (Table 4.1.2: Row two). The spatial dimension is argued to relate to the difficulty to reach a destination to participate in society (Halden et al., 2005). Despite the fact that Church et al. (2000) did not mention a spatial dimension, Church et al. (2000) have taken into account the difficulty to reach the activities by proposing geographical exclusion and exclusion from facilities as two separate dimensions of transport related social exclusion (Yigitcanlar et al., 2019). Exclusion from facilities is seen as the lack of facilities like shops, health care and education within

a feasible distance, while geographical exclusion focuses on the availability of transport services within a feasible distance (Lucas, 2012). An individual living in a rural area has reduced accessibility as a result of the lack of public transport and the lack of key facilities within a reachable distance. Due to the difficulty for the individual to reach the key facilities the individual might not execute the journey, which can result in inadequate participation in society eventually leading to a certain degree of transport related social exclusion (Social and Transport Research Services, 2000).

An information dimension was only mentioned by two of the five investigated studies (Table 4.1.2: Row three). Yigitcanlar et al. (2019) suggested that information about his or her transport options is required for an individual in order to plan their own travel movement. The information dimension refers to the way of providing information, while also taking into consideration the ability of the individual to use the provided information (Yigitcanlar et al., 2019). If an individual is not able to access the available options as a result of missing information or if the individual lacks the ability to acquire the information, he or she will not be able to plan and execute the journey and this might affect the individual's participation in society (Schwanen et al., 2015). Information has become even more important the last two decades, because ICT ensures substitutes and complements to travel options. The extra information that can be obtained through the internet results in new travel options for the individual to reach their activities (Cairns et al., 2004). Halden et al. (2005) even concluded that as a result of increasing ICT, the relative importance of the information dimension increased.

The last two dimensions were only mentioned by one of the five investigated studies (Table 4.1.2: Row four and five). The organizational dimension was indicated by Cass et al. referring to "people's ability to access services and facilities depends not just on the forms of transport available but also on how they are organized" (Cass et al., 2005, p. 550). The focus of this dimension is on the ability of the individual to be accessible (Rashid et al., 2009). In other words, an individual could have multiple travel options, but is not able to combine the travel options in order to reach his or her preferred destination. To illustrate this dimension, the availability of a car ride is of greater importance than being the owner of a car, because the actual ride ensures the individual to reach key activities and fully participate in society. The space exclusion dimension, suggested by Church et al. (2000), indicates the fact that security or space management prevents particular individuals from entering public spaces. For example, to enter the stations of NS, the biggest passenger railway operator, a card is needed, which means that an individual without a card is not able to enter this quasi-public transport space. Even though every individual can buy this particular card, the security management prevents individuals without a card to enter the station.

Table 4.1.2: Disagreement among researchers about dimensions of transport related social exclusion

Church (2000)	Hine & Mitchell (2001)	Halden et al. (2005)	Cass et al. (2005)	Yigitcanlar et al. (2019)
Fear-based exclusion	<i>Psychological</i>	Environmental	(Psychological aspect mentioned in Physical dimension)	<i>Psychological</i>
Geographical Exclusion	<i>Spatial</i>	<i>Spatial</i>	-	<i>Spatial</i>
Exclusion from facilities				
-	-	<i>Information</i>	-	<i>Information</i>
-	-	-	<i>Organizational</i>	-
Space Exclusion				

4.1.2 Proposed Included Dimensions for this Research

The dimensions proposed by the studies have some overlap, partly due to the different approaches used to obtain the dimensions. This subsection substantiates which dimensions are researched in more detail in the next section, wherein the underlying potential exclusionary factors are disclosed. Six of the eight suggested dimensions are considered in the next section (Figure 4.1.1).

The economic, temporal and physical dimensions were mentioned by all five studies, which substantiates the choice to incorporate these three dimensions. All these three dimensions consist of both personal circumstances and transport characteristics that can pose a barrier to accessibility (Halden et al., 2005). For example the financial dimension consists of both the financial management of the individual and the costs of transport. Both personal circumstances as well as transport characteristics may negatively affect an individual's accessibility. For that reason in the next subsection (Subsection 4.2) a distinction will be made between barriers as a result of an individual's characteristics and abilities, and the design of the transport system. Nevertheless, a note needs to be made about the interrelationship of the personal circumstances and transport characteristics, because personal circumstances can deepen the transport characteristics and vice versa (Social and Transport Research Services, 2000). If an individual has a relatively low income, the costs of public transport will have a larger impact on his or her ability to travel than when the individual has a relatively high income.

Besides the three dimensions the researchers agree on, three other dimensions will be examined in more detail. First, the psychological dimension. This dimension was not mentioned by Cass et al. (2005). Nevertheless, Cass et al. (2005) also concluded that fear or stress can potentially withhold individuals from performing a journey. Second, the spatial dimension will be examined as one dimension. The distinction between the two dimensions proposed by Church et al. (2000) to cover the spatial factor is imprecise (Hine & Mitchell, 2001). Finally, the information dimension is included, because ICT gained importance in order to travel seamlessly (Halden et al., 2005). The suggestion of Halden et al. (2005) that ICT has become more and more important in order to travel is demonstrated by the fact that the NS nowadays sends messages to notify a traveler in the event of a train failure or train delay (NS, n.d.). Therefore, the conclusion of Halden et al. that the increasing importance of ICT reduces the relative importance of the spatial, physical

and environmental dimensions relative to economic and information dimension is represented in figure 4.1.1 by making these two dimensions thick-edged.

The organizational dimension will not be researched any further, because it is both difficult to generalize these individual abilities to a particular group due to unavailable data and moreover the personal circumstances of an individual will be considered within the other dimensions (Cass et al., 2005). It is difficult to measure the dimension due to the fact that it depends on an individual's ability to use the offered services (Yigitcanlar et al., 2019). Besides, the abilities of an individual will be considered for all the different dimensions, because the personal circumstances like the ability to read Dutch information boards will be considered as a potential posed barrier. By taking into account the personal circumstances of an individual for the different dimensions a distinct organizational dimension is considered unnecessary for this research. Last, the space exclusion dimension will be omitted, because the exclusion as a result of security management strategies is a result of the lack of ability to understand how to enter these spaces (Church et al., 2000). So, for this dimension the same applies as for the organizational dimension: the abilities of the individual are represented by the other six dimensions as the personal circumstances.

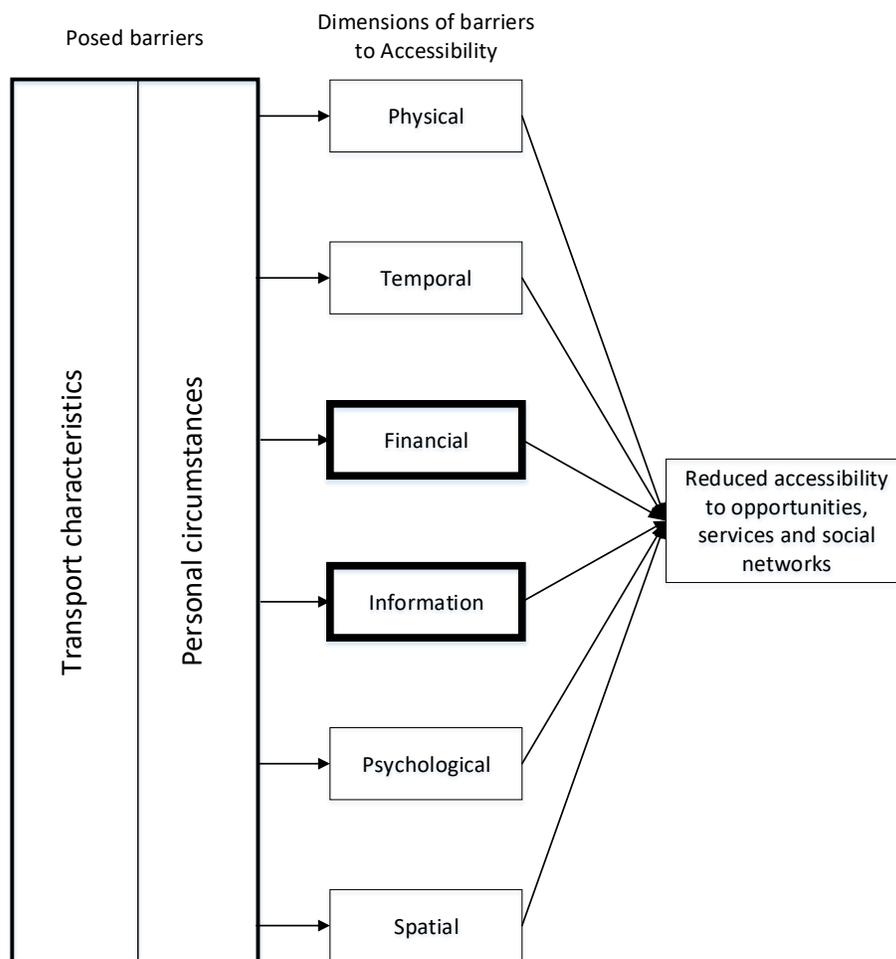


Figure 4.1.1: Schematic overview of dimensions explaining reduced accessibility

4.2 Underlying Potential Exclusionary Factors

In the previous subsection the different dimensions that explain reduced accessibility were identified. In this subsection the underlying potential exclusionary factors of the six identified dimensions will be exposed. Various researchers have focused on identifying the most vulnerable groups (Currie, 2010; Goeverden et al., 2006; Jorritsma et al., 2018; Kampert & Dahlmans, 2018; Lucas, 2004; Ma et al., 2018). However, this research focuses on the factors or posed barriers that result in reduced accessibility, which might eventually lead to a certain degree of transport related social exclusion as a result of inadequate participation (Subsection 3.1). The factors that are exemplary for the vulnerable groups will be included as potential exclusionary factors for the dimensions. Besides, the factors suggested by researchers to explain reduced accessibility will be included in the framework. In subsection 4.2.1 up to and including subsection 4.2 the underlying factors that result in reduced accessibility are explained per dimension. In these subsections a distinction will be made between the personal circumstances of the individual that pose a barrier resulting in reduced accessibility and the transport characteristics that affect an individual's accessibility. Thereafter in subsection 4.2.7, the different dimensions and their potential exclusionary factors will be combined in one single framework. In addition the overlap and relationships between the dimensions and potential exclusionary factors will be explained and justified in this same subsection.

4.2.1 Potential Exclusionary Factors of the Physical Dimension

The physical dimension represents the physical capabilities of an individual to execute a journey, while taking into account the design of the selected transport modality (Rashid et al., 2009). Three factors were derived from the literature that are considered potential exclusionary factors of the physical dimension:

1. disability or impediment
2. being older than 65
3. the lack of adjustments to public transport

The first two factors are personal circumstances, whereas the third factor of the physical dimension is a transport characteristic (Figure: 4.2.2).

Disability or impediment

In the literature several researchers have identified individuals with a disability as a vulnerable group (Currie, 2010; Lucas, 2012; Mackett & Thoreau, 2015; Moore et al., 2013). A disability such as blindness for example makes it more difficult to travel to reach key activities and thus to participate in society. The disability factor represents all possible disabilities and impediments that result in difficulties for an individual to travel independently. In the Dutch society 29.2 % of the population has difficulties to participate in a way that is considered the normal standard within the Dutch society due to an impediment according to the Global Activity Limitation Indicator (CBS, 2020). It can be concluded that almost one out of every three citizens within the Dutch society has an impediment that affects his or her participation in society and thus is socially excluded. Nevertheless, it cannot be concluded that this group is transport related socially excluded, because the inadequate participation can be the result of one of the excluded dimensions of social exclusion (Section 3.1).

Older than 65

The elderly, represented as individuals older than 65, are included as a separate group. The reason for that being that Currie (2011) reviewed other studies and seven out of eight of these studies concluded that elderly are a group prone to be socially excluded. Elderly have the smallest activity spaces due to the difficulty of executing long trip distances (Moore et al., 2013). For example a journey with multiple transfers requires more energy from the elderly, which thus impacts the number and types of journeys the elderly make (Cairns et al., 2004). It can be argued that being old is a certain impediment, because aging affects muscle mass and strength. Therefore, the elderly that face physical obstacles while travelling are already included in the percentage of the global activity limitation indicator of CBS (CBS, 2020). Despite the fact that these two personal circumstances were considered two separate potential exclusionary factors, in this research the elderly are considered to represent a large portion of the individuals that are unable to participate as a result of an impediment or disability. For that reason the factor age 65+ will be seen as an important explanatory factor of the "disability or impediment factor" (Figure 4.2.1). The population older than 65, elderly, will not be considered to have reduced accessibility anyway, but the elderly are considered to have a higher chance on a disability or impediment that influences the elderly's accessibility.

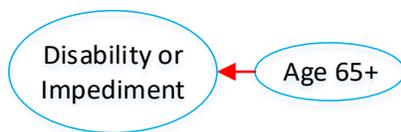


Figure 4.2.1: Population 65+ are a big share of the population with a disability or impediment

Lack of adjustments

Apart from the personal circumstances of the physical dimension, the lack of adjustments made to the public transport is also considered a transport characteristic of the physical dimension that causes reduced accessibility. Engineering solutions are usually proposed to assist individuals to enable them to travel independently (Mackett & Thoreau, 2015). For example ramps, lifts and escalators are built in order to assist the travelers using a wheelchair in changes of level. Besides, adjustments have to be made to the transport modalities in order to ensure access, because the goal of the government is to create public transport that is accessible for everyone (Rijksoverheid, n.d.). Nevertheless, Rijksoverheid (n.d.) concluded that not all the train stations have made the necessary adjustments to ensure that individuals in a wheelchair can access them. Therefore, the "lack of adjustments made to public transport" is considered a factor resulting in reduced accessibility (Figure 4.2.2).

It is of great importance to note that the design of the transport modality can contribute to the ability of an individual to travel independently. If the Dutch government makes all the necessary adjustments to ensure an individual in a wheelchair can travel independently, the disability of the individual will no longer be a potential exclusionary factor. The more adjustments made to public transport the less an individual's personal circumstances are a barrier to travel. Therefore, in figure 4.2.2 the interrelationship between both the personal circumstances and transport characteristics within the physical dimension is represented with the black circle arrows.

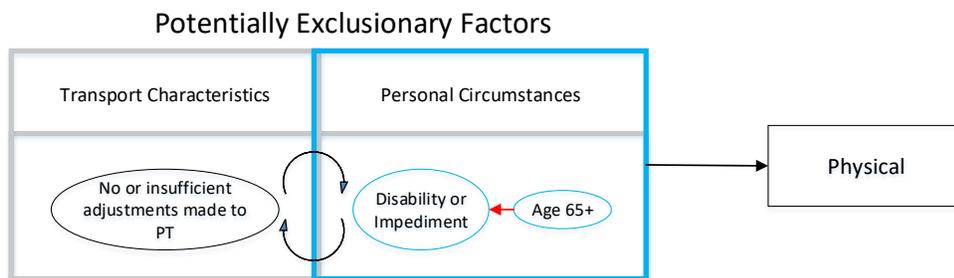


Figure 4.2.2: Physical Dimension

4.2.2 Potential Exclusionary Factors of the Temporal Dimension

The temporal dimension represents the difficulties to travel due to time constraints (Church et al., 2000). From the literature six barriers to accessibility related to the time constraints can be derived, three of them are related to the personal circumstances (Figure 4.2.3):

- No access to a car (or another motor vehicle)
- No access to a bike
- No time available to travel

Besides, three are related to transport characteristics (Figure 4.2.3):

- Low frequency public transport
- No public transport at certain parts of the day
- Long travel time

Car and bike unavailability

In the literature several researchers suggested that car ownership is an important indicator to indicate the level of accessibility and thus transport related social exclusion (Kampert et al., 2019; Moore et al., 2013). However, most of the researchers concluded that car ownership is a potential exclusionary factor of the financial dimension (Lucas, 2004; Lucas 2012; Rashid et al., 2009). Nevertheless, in this research the unavailability of a car is taken into account as a barrier of the temporal dimension as well, because a car is the fastest transport modality in the Netherlands for both short and long distances (Van Beuningen, 2013). Besides the unavailability of a car, the unavailability of a bike is considered as well due to the fact that the Dutch Central Bureau of Statistics (CBS) concluded that for distances shorter than 7.5 kilometers a bicycle is a faster transport modality than public transport (Van Beuningen, 2013). Due to the fact that both of these transport modalities have their time savings for the individual for different distances, the unavailability of the transport modality can result in time consuming public transport for the individual. As a result of the extra time necessary to accomplish the journey, the unavailability of either one of the two transport modalities results in reduced accessibility.

Unavailability of time for travel

The third and last personal circumstance within this dimension that has been derived from the literature is the unavailability of time for travel. Lodovici suggested in 2015 that an individual can have reduced accessibility as a result of combined demands on time. An individual only has 24 hours a day to fulfill all of

his or her tasks. If an individual has for example combined work or child care duties, he or she will have less time available to go to the shops. As a result of the lack of time the individual is not able to travel to key activities in order to fully participate in society (Social and Transport Research Services, 2000).

Frequency and availability public transport

Besides the personal circumstances that pose barriers related to the temporal dimension, the design of the transport system may also result in barriers for the individual. Jorritsma (2018) concluded that an individual's accessibility is closely related to the frequency of the public transport. As a result of a certain timetable of the public transport provider, an individual is only able to use public transport at the scheduled hours. As a result of low frequencies of public transport the individual might be unable to reach the activities on time (Yigitcanlar et al., 2019). Besides, if the public transport provider does not run at certain times for example during the night, the individual will not be able to reach the desired destination at all. The frequencies and the availability of public transport during the night are closely related to an individual's geographical location. The frequency and availability of the public transport are higher in cities than in rural areas. Therefore, Church et al. (2000) concluded that a rural population is considered a vulnerable group. However, for this particular dimension the rural area is divided in these two factors, frequency and availability of public transport, because these two factors especially apply for the negative factors of the rural area for the temporal dimension (Lucas, 2004).

Long travel time

In rural areas travel times are relatively longer due to the fact that facilities such as shopping, healthcare and family are in average further away (Church et al., 2000). However, the "long travel time" barrier is not solely related to individuals living in rural areas. Area accessibility is related to the facilities an individual can reach in a certain time (Kamruzzaman et al., 2016). Obviously the travel time is related to both the location and the speed of the used transport modalities to perform a journey, which shows the interrelationship between on the one hand the personal circumstances, used modalities, and on the other hand the transport characteristics, in this case the geographical location of the individual (Kampert interview, 20th April 2020) (Figure 4.2.3).

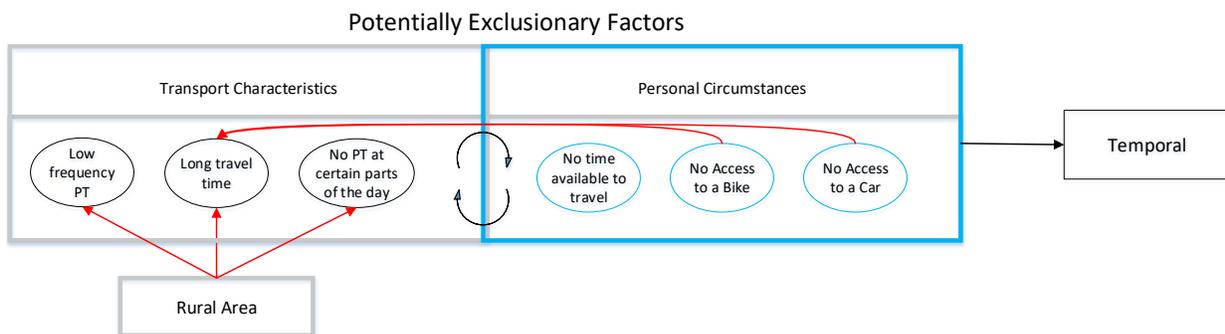


Figure 4.2.3: Temporal Dimension

4.2.3 Potential Exclusionary Factors of the Financial Dimension

The financial dimension represents a clarifying dimension of accessibility due to the fact that the financial potential exclusionary factors are assumed to be easily measurable (Halden et al., 2005). The monetary

factors resulting in reduced accessibility are included in this dimension representing the lack of funds of an individual to use the existing transport facilities (Hine & Mitchell, 2001). The factors derived from the literature resulting in low transport budget are (Figure 4.2.5):

- No job
- Low Income
- High expenses

Besides, two factors are derived from the literature related to the costs of transport:

- High fares public transport
- High total costs of ownership private transport

Budget available for transport

For an individual it is of great importance to have sufficient monetary funds in order to be able to pay for the necessary transport (Kampert interview, 20th April 2020) (Rashid et al., 2009). 22 out of the 33 international experts interviewed by Yigitcanlar (2019) suggested that if 15% or more of the income is spent on public transport, the individual will have reduced accessibility and a higher risk on transport related social exclusion. Yigitcanlar (2019) had the same outcome for private transport costs, which implies that if 15% or more of the income is spent on private transport, the individual will have reduced accessibility and a higher risk on transport related social exclusion. If an individual spends more than 45% of his or her total budget on private or public transport, respectively 87.9 and 93.9 % of the experts suggested that the factor is a potential exclusionary factor of the financial dimension resulting in transport related social exclusion.

However, the transport budget of an individual for transport is determined by different factors. In the literature individuals without a job or with a low income are considered to be one of the most vulnerable groups (Cairns et al., 2004; Church et al., 2000; Litman, 2003; Lucas, 2012; Moore et al., 2013). The factors "no job" and "low income" indicate an individual's available budget for both public and private transport. Nevertheless, these two factors only consider the flows of money the individual receives. Importantly, in order to determine the available budget of an individual the expenses other than transport related expenses need to be taken into account as well to obtain the individual's transport budget (Lodovici et al., 2015). If an individual has to support a large family, the expenses besides the transport expenditures will negatively influence the available budget for both private transport and public transport. The "Low income", "No job" and "High expenses" factors will be used to examine whether an individual's budget for transport is sufficient or not. All of these three factors have a negative effect on an individual's budget (Figure: 4.2.4).



Figure 4.2.4: Factors negatively influencing an individual's transport budget

Costs of transport

Besides the personal circumstances, the financial dimension also consist of transport characteristics that pose barriers resulting in reduced accessibility. For the financial dimension both the costs of public transport, "High fares of public transport", and the costs of private transport, "High total costs of ownership private transport" are included in the framework (Figure 4.2.5). Both these factors are considered in this research, because at the moment the two possible ways to travel as an individual are by using public transport or by using a private owned transport modality including walking. In this research the total costs of ownership are chosen for as a factor instead of costs of ownership, because the concept total costs of ownership tries to include every cost associated with owning a transport modality, both purchases costs as well as running costs (Clerck et al., 2016).

An individual has to use transport modalities to end up at the key activities and participate in society. However, the high costs of the available transport can prevent an individual from executing a journey. In 2019 the costs of public transport rose more than the total costs of a private car (CBS, 2019b). As a result of the disproportionate increase of these two ways of travel, the lower income households in automobile dependent communities without access to a car are forced to spend an exorbitant portion of their total budget on public transport (Litman, 2003).

An important policy instrument used by the Dutch Government to remove this barrier are subsidies (Goeverden et al., 2006). However, if the individual is still not able to afford either private transport or public transport, the individual will have reduced accessibility and a higher risk on transport related social exclusion. The prices of transport will only an issue, if an individual does not have sufficient transport budget. Therefore, the link between the personal circumstances, unavailable budget, and transport characteristics, costs of transport, are linked with arrows (Figure 4.2.5).

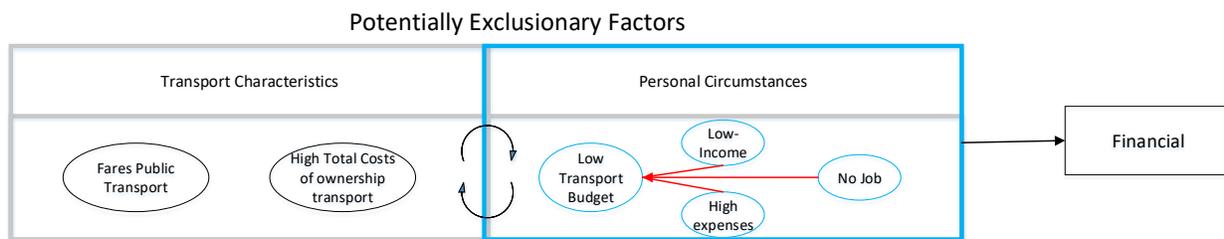


Figure 4.2.5: Financial Dimension

4.2.4 Potential Exclusionary Factors of the Information Dimension

The information dimension refers to the way in which information is provided, while taking into consideration the individual's ability to use the information provided. In the definition of the information dimension a firm distinction has already been made between on the one hand the availability of the information, the transport characteristics, and on the other hand the ability to use the provided information, the personal circumstances (Yigitcanlar et al., 2019). The literature suggests four transport characteristics (Figure: 4.2.7):

- No journey information at stops
- No service information desk

- No stop information in public transport
- No digital information"

Besides, four personal circumstances were derived (Figure: 4.2.7):

- No internet
- Difficulties to access digital information
- Poor literacy level
- No awareness of transport services

In the literature the researchers mostly focus on the information provision of the public transport. Nevertheless, information about traffic jams and roadblocks are of great help for the car users as well. In this subsection the main focus will be on the information provision of public transport, while not overlooking the information provision for the private transport modalities.

Awareness of available transport services

According to Cairns et al. (2004) it is of great importance to increase awareness among the travelers about the availability of transport services. If an individual is not aware of the existing transport modalities, the particular individual will not be able to use the transport services and reach the key activities. Lucas (2004) suggested that one of the reasons why an individual is not able to access information is a low literacy rate. A poor ability to access information has a direct impact on the use of the transport system (Lucas, 2004). However not only the population with low literacy rates experiences difficulties in accessing information. Nowadays, "increasingly ICT provides substitutes and complements to travel options" (Halden et al. 2005, p. 10). Even though Halden et al. (2005) concluded in 2005, that ICT and digital information are becoming more and more important, this may be even more true in 2020. The access to internet is required in order to access the digital information provided by the transport services. However, even in the Netherlands 5.1 percent of the population has never used the internet (CBS, 2019c). Therefore, the digital information cannot be accessed by this group. On top of this group without internet access, the Dutch government concluded that in 2018 2.5 million, almost 15% percent of the Dutch population, has difficulties with the digitalization of the society (Ministry of the Interior and Kingdom Relations, 2018). So, these three factors can be appointed to influence an individual's ability to access the provided information and thus their awareness of the available transport services (Figure 4.2.6).

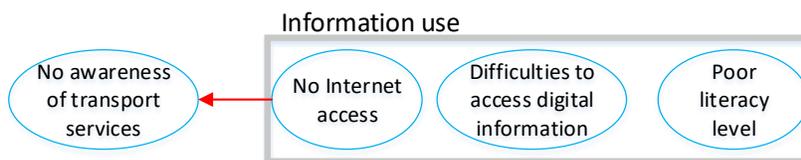


Figure 4.2.6: Three factors influencing an individual's awareness of transport services

Provided information

The transport services need to provide adequate information to their customers, travelers, in order to offer their supply of mobility to the individuals. Dziekan (2007) even concluded that provision of

information is crucial for public transport companies in order to have individuals planning and executing a journey with their company. The consulted experts by Yigitcanlar (2019) suggested that both the lack of physical information, "No journey information at stops" and "No service information desk", and the lack of digital information, "No stop information in public transport" and "No digital information", could pose a barrier to accessibility. The lack of information in general might result in stress due to the fact that the individual is groping in the dark about for example the arrival time (Dziekan, 2007). The digital real time information can be of great importance to positively influence an individual's experience about the journey (Dziekan, 2007). The transport services should provide information in as many possible ways as they can. However, due to the high costs service information desks are cut back (Rover, 2019). Besides, next to the digital information it is of great importance to provide analog information, for example timetables, to serve the population without a device connected with the internet. If one of the provisions of information is missing, an individual in need of this particular information channel will have reduced accessibility.

An important notion about the link between the ability to access information and the provision of information by the transport services is that the more information channels, both analog and digital, used to provide the information, the less individuals will be confronted with a barrier to accessibility (Figure: 4.2.7).

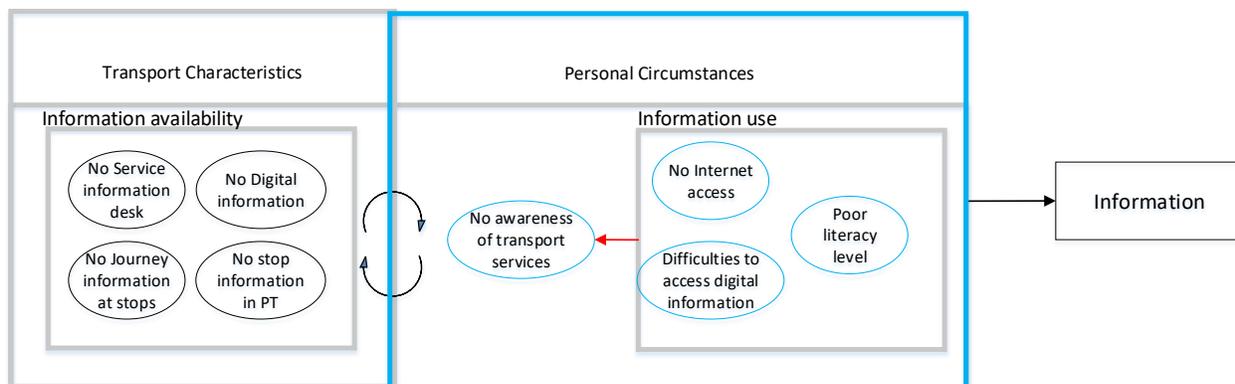


Figure 4.2.7: Information Dimension

4.2.5 Potential Exclusionary Factors of the Psychological Dimension

The fifth dimension that is looked into in more detail is the psychological dimension, which refers to the fear or stress an individual experiences at any stage of a journey (Hine & Mitchell, 2001). Due to the stress or fear an individual is experiencing, the particular individual might not perform the journey, resulting in reduced accessibility for the particular individual (Yigitcanlar et al., 2019). For this dimension six factors are suggested:

- Being elderly
- Being a woman
- Lack of trust in public transport
- Feeling unsafe
- Poor security
- No ticketing and information counter

The first four factors are considered to be personal circumstances, while the last two factors are considered transport characteristics (Figure: 4.2.9).

Fear and trust

At first the personal circumstances of the psychological dimension that pose a barrier to accessibility will be discussed. Women are considered to be one of the vulnerable groups for reduced accessibility and thus transport related social exclusion (Lodovici et al., 2015; Mackett & Thoreau, 2015; Moore et al., 2013). Both Mackett & Thoreau (2015) and Lodovici et al. (2015) suggested that safety and security in public transport disproportionately affects women. As a result of the lacking safety measures women feel unsafe and are not using buses as often as men (Mackett & Thoreau, 2015). Besides women, Lodovici et al. (2015) suggested that security and safety management also affects the elderly's safety experience more than other groups. These two factors alone will not pose a barrier to accessibility, but if an individual, a woman, an elderly person or any other individual, is not executing a trip as a result of feeling unsafe, the particular individual will experience reduced accessibility. Therefore, these two vulnerable groups are of great importance to determine the factor "Feeling unsafe", because these two vulnerable groups are considered to have a higher risk of feeling unsafe in public transport (Figure: 4.2.8). The environment determines the safety feeling of the individual, because for example poor lightning or areas with a high criminal rate are negatively influencing the safety feeling.

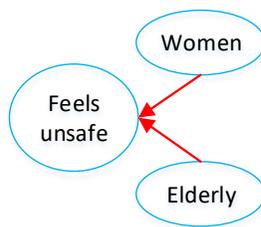


Figure 4.2.8: Women and elderly have lower sense of security compared to other groups

Besides fear, an individual's lack of trust in public transport might also pose a barrier to an individual's accessibility (Dziekan & Kottenhoff, 2007). If an individual trusts the provided information by the public transport companies, the journey will be easier for the traveler (Dziekan & Kottenhoff, 2007). For private transport modalities trust is not considered an issue in the literature. The reason for this is most probably that the individual has made a deliberate choice about using his or her private transport modality, while an individual using public transport may be forced to use public transport, because of the lack of a private car for example (Lucas, 2004).

Safe environment

The role of the transport services, especially public transport operators, is to offer safe and seamless travel options for the customers, otherwise the lack of safety measures will result in barriers to accessibility (Ma et al., 2018). As already discussed as a factor of the information dimension, the lack of a ticketing and information counter could withhold individuals from an easy journey (Rover, 2019). For some individuals an information counter contributes to the experience of their journey, because it offers the particular individuals the possibility to ask for help for example to plan their journey or to adjust their journey due to delays (Dziekan & Kottenhoff, 2007). The United Nations Human Settlements Programme (2013)

concluded that some people are not able to travel due to the poor security. Therefore, "poor security" is included in the framework as a potential exclusionary factor (Figure: 4.2.9).

For this dimension the personal circumstances and transport characteristics are related once again. However, some of the personal circumstances are difficult to overcome with appropriate measures due to an individual's perception of security instead of a measurable shortcoming (Ma et al., 2018). For that reason in this schematic overview of the psychological dimension the transport characteristics, shortcomings of the transport services that result in lack of trust and feelings of unsafety, have an impact on the personal circumstances and not the other way around (Figure: 4.2.9).

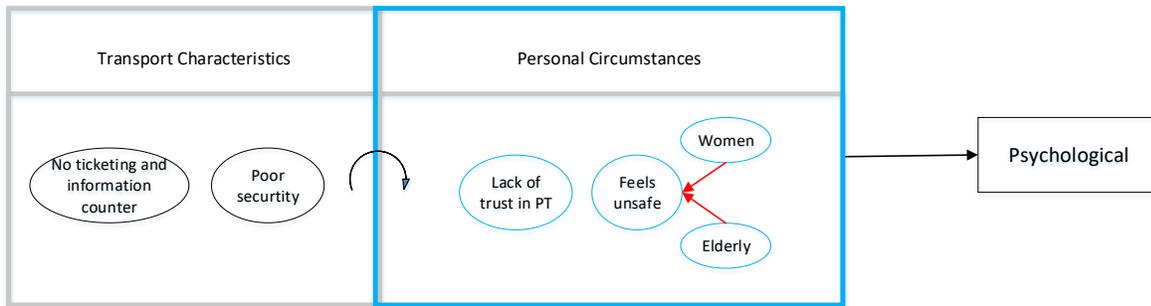


Figure 4.2.9: Psychological Dimension

4.2.6 Potential Exclusionary Factors of the Spatial Dimension

The last dimension of interest is the spatial dimension, which refers to the difficulty to reach a destination to participate in society (Halden et al., 2015). This dimension consists of both the travel options within a region and the distance of the necessary facilities to adequately participate in society (Church et al., 2000). The transport characteristics of this dimension are closely related with the geographical location of an individual. The geographical location is divided into four potential posed barriers derived from literature resulting in reduced accessibility namely (Figure: 4.2.12):

- Long distance to facilities
- Long distance to bus/tram/metro station
- Long distance to train station
- No walkable neighborhood environment

Potential exclusionary factors resulting from the lack of travel options, related to an individual's personal circumstances, are (Figure: 4.2.12):

- No driving license
- No car ownership
- No or lacking ability to arrange a ride
- No access to a bike

Availability of private transport modalities

The researchers mainly focus on car ownership in order to examine whether an individual has adequate travel options to reach the desired destination. The main reason of this focus of the different researchers

on the private car is due to the fact that almost 75% of the total distance traveled by the Dutch population is done by car (Netherlands Institute for Transport Policy Analysis, 2019). Kampert et al. (2019) used car ownership as an indicator to measure an individual's risk on transport related social exclusion. Mackett & Thoreau (2015) and Moore et al. (2013) indicated individuals without car ownership as vulnerable to transport related social exclusion. Lucas (2004) suggested that access to a car is essential to fully participate in economic and social life. The difference between Kampert et al. (2019) and Lucas (2004) is that Lucas (2004) concluded that access to a car is essential, which not necessarily implies that an individual needs to own a car. Therefore, the lack of a car results in reduced accessibility, but if an individual, besides lacking a car, is also not able to arrange a ride, the individual will be confronted with another barrier to accessibility. Besides, if an individual's household owns a private car, the individual needs to have a driving license in order to be permitted to drive the available car. Therefore, the three factors, "No car ownership", "No driving license" and "The ability of an individual to arrange a ride" determine an individual's access to a car, the main used transport modality in the Netherlands (Netherlands Institute for Transport Policy Analysis, 2019) (Figure: 4.2.10).

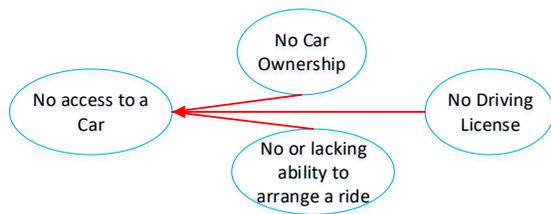


Figure 4.2.10: Three factors negatively influencing an individual's access to a car

In the literature the focus is on the car, because the researchers focus mainly on automobile dependent countries. However, in the Netherlands 26% percent of the journeys are made using a bike (Netherlands Institute for Transport Policy Analysis, 2019). For that reason the access to a bike is considered to be of importance for an individual's accessibility in the Netherlands (Kampert interview, 20th April 2020).

Geographical location

The transport characteristics that pose a barrier for the spatial dimension can be mainly attributed to the geographical location of the individual. Ma et al. (2018) concluded that a walkable neighbourhood leads to an increase of transport related social inclusion. A walkable neighborhood consists of the multiple key facilities and necessary transport services to fully participate in society. The density of transport services and facilities is higher in regions with higher population densities, opposed to rural areas. The population living in rural areas has a higher risk on transport related social exclusion (Litman, 2003; Lucas, 2012; Moore et al., 2013). Characteristics of rural areas are "long distances to facilities", "long distances to bus/tram/metro" and "long distances to train station". These three factors determine whether the neighborhood is walkable or not in this research (Ma et al., 2018) (Figure 4.2.11).

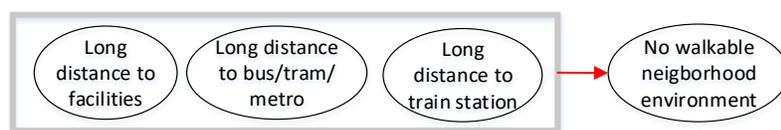


Figure 4.2.11: Distances to public transport and facilities determine whether a neighborhood is walkable

It is difficult for a transport service to take away these posed barriers, because operating in the rural areas is not profitable due to the small amount of customers. Therefore, subsidies are the only way to ensure public transport for the rural residents (Goeverden et al., 2006). The transport services role in reforming the transport characteristics for this particular dimension is minimal. The transport characteristics and personal circumstances are linked though, but the two do not influence each other (Figure 4.2.12).

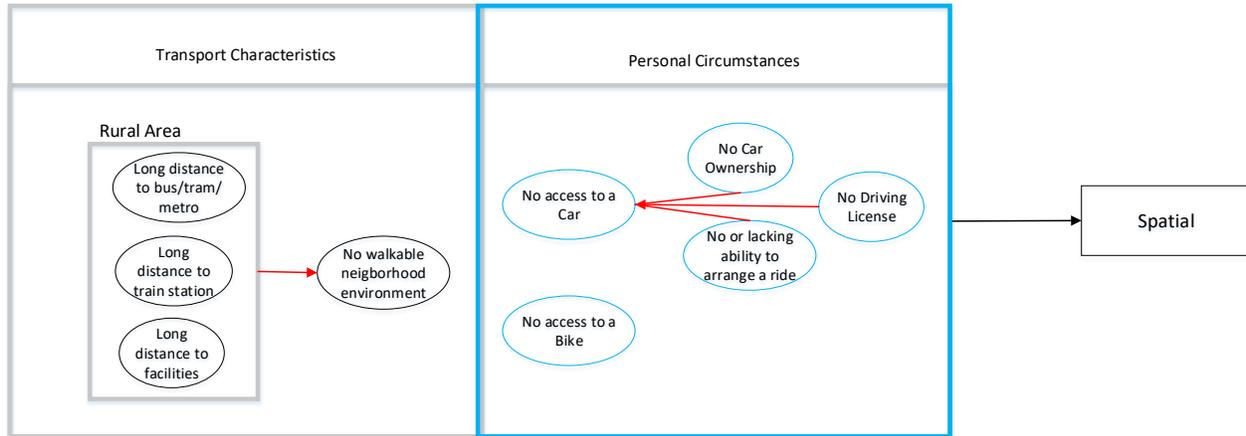


Figure 4.2.12: Spatial Dimension

4.2.7 Merge the Exclusionary Factors into an Overarching Overview

The different potential exclusionary factors are combined in an overarching overview (Figure 4.2.13). The aim of this figure is to show the difficulty of addressing the particular posed barriers that prevent an individual from participating in society. The complexity of the transport related social exclusion is represented by the multiple potential exclusionary factors. Another goal of figure 4.2.13 is to show that the dimensions themselves are not resulting in reduced accessibility and thus a higher risk on transport related social exclusion, but the underlying potential exclusionary factors are posing a barrier to an individual's accessibility.

Moreover, the information and financial dimensions are outlined thicker than the other dimensions, because as already mentioned the relative importance of these dimensions is higher due to the increased ICT within the transport system (Halden et al., 2005). Additionally some overlap between the six dimensions can be derived. For example if an individual is living in a rural area, the individual will experience several posed barriers corresponding to the spatial dimension. The individual will have longer travel time, which implies a potential exclusionary factor corresponding to the temporal dimension (Figure: 4.2.13: A). Another example is the lack of an available car, which is a potential exclusionary personal circumstance of both the temporal dimension as well as the spatial dimension (Figure: 4.2.13: B). Therefore, even though the figure presents the underlying factors of reduced accessibility as a clear and distinguishable concept, it needs to be pointed out that the reality is more complex.

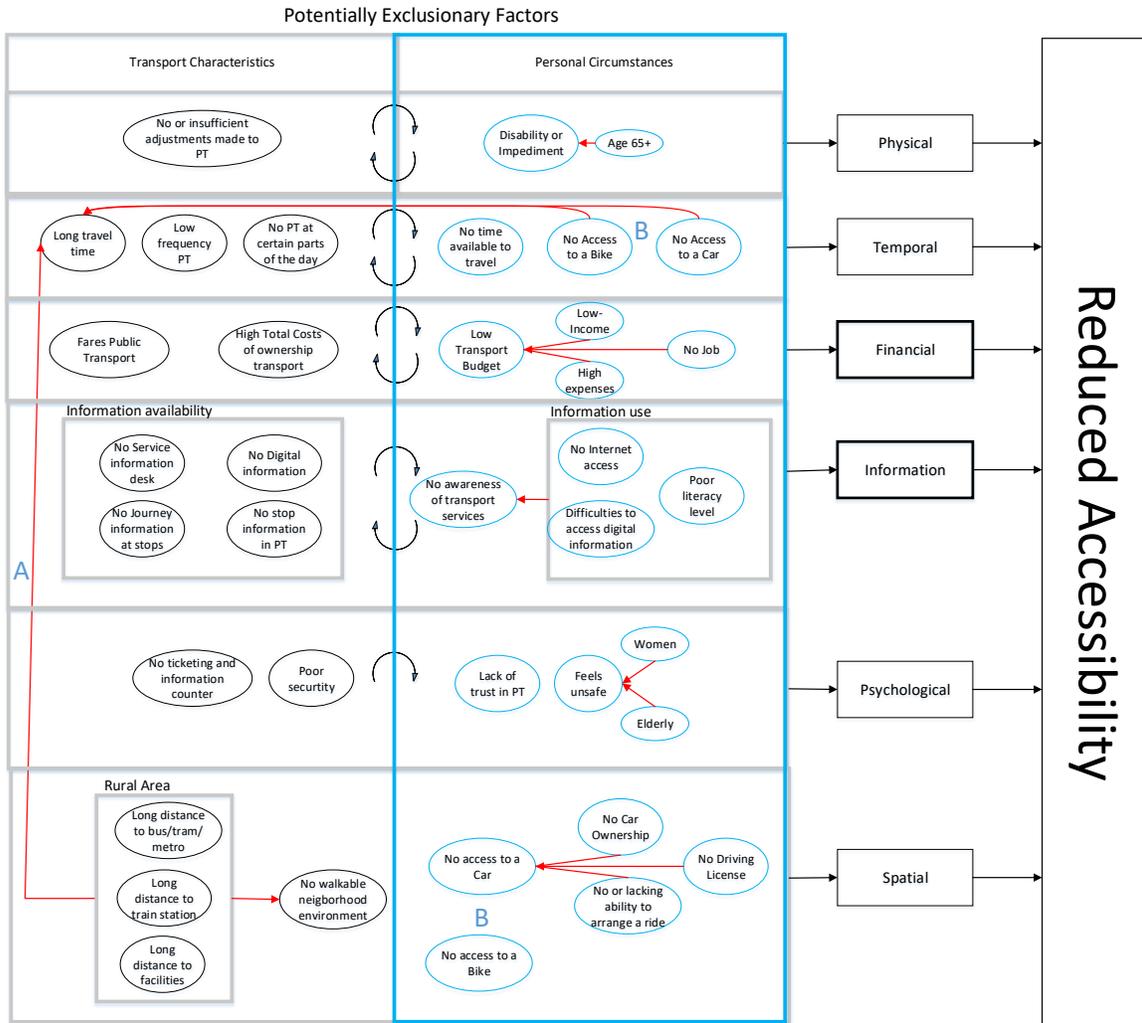


Figure 4.2.13: Overarching overview of all the potential exclusionary factors per dimension

5. Effects of MaaS on Identified Potential Exclusionary Factors

The demarcation of the key concept, Mobility as a Service, and the identification of the barriers resulting in reduced accessibility are essential in order to examine the effects of the introduction of MaaS on transport related social exclusion. Studying the literature made it possible to derive these effects and by that complete the conceptualization of the framework representing the effects of MaaS on transport related social exclusion on the basis of an extensive literature review. The effects of MaaS on potential exclusionary factors, hypotheses, formulated on the basis of the reviewed literature will be tested and adjusted where necessary in the next chapter using empirical data obtained through in-depth interviews.

At the moment some research data about the effects of MaaS are available. However, these data are obtained by analyzing the early adopters of MaaS. The goal of this research is to uncover the impacts on the population with a high risk on transport related social exclusion. Therefore, the available data of operational MaaS platforms such as Ubigo will not be of useful for this particular research, because their focus is on the change of travel behavior of the early adopters, the mobile population (Karlsson et al., 2016). Nevertheless, in the case that researchers have suggested some impacts of MaaS on the identified potential exclusionary barriers, these suggestions will be used to help establish the hypotheses. So, the goal of this chapter is to formulate all possible hypotheses that can be developed on the basis of literature and that are related to one of the potential exclusionary factors. The hypotheses are derived from literature and are explained in subsection 5.1 up to and including subsection 5.4. In conclusion the formulated hypotheses will be presented in a schematic overview in subsection 5.5.

5.1 Digitalization of the Transport Sector

First of all one of the main drivers of MaaS is the digitalization (König et al., 2016). The MaaS platform can only be accessed by using a device that is connected with the internet (Li & Voegelé, 2017). MaaS relies on a digital platform, a mobile app or a web page, through which the customers can plan, book and pay for their trip, while receiving real-time information (Jittrapirom et al., 2017). For an individual all the necessary information to execute a trip is presented in one easy understandable app (König et al., 2016). The provided information about all the aspects of the journey removes the barrier identified in subsection 4.2.4, no digital information. However, as a result of the reliance on digitalization the introduction of MaaS might further exclude the population experiencing difficulties in dealing with new technologies (Pangbourne et al., 2020). People experiencing difficulties with accessing digital information can be assumed to be resistant in their lack of knowledge, since the growing importance of the ability to access digital information can be assumed to be a great motivation. Notwithstanding that, these people are still digitally illiterate as concluded in subsection 4.2.4.

In conclusion, the digitalization improves the digital information provision for the end-users of MaaS, but this digital information requires certain abilities and a smartphone with an internet connection, which are not self-evident for the Dutch society as a whole as discussed in subsection 4.2.4. Therefore, it can be concluded that the digitalization of the transport sector has impact on two identified potential exclusionary factors of the information dimension, difficulties in accessing digital information and difficulties in obtaining digital information.

5.2 More Affordable Mobility

Another impact of the introduction of MaaS is related to the financial dimension. One financial consequence is that a MaaS provider is considered to be able to negotiate about the ticket prices, because the provider is able to prepay trips in bulk (König et al., 2016). Therefore, the provider is able to get lower

prices, which ensures a more affordable transport system for the end-users. Another financial consequence that is suggested is that “MaaS may contribute to increased cost-efficiency of public spending in providing traditional PT access to citizens” (Smith et al., 2018, p. 597). In the current situation subsidies and other policies do not always end up at the right people. For example, every student receives a student travel discount to ensure all students can afford the necessary mobility to attend education. Nevertheless, some students use their discount for purposes other than going to university. If the Dutch government has specific knowledge about travel behavior, they will be able to allocate their monetary funds in a more efficient manner (Smith et al., 2018). Nevertheless, the Dutch government first has to learn from the available data in order to actually improve the allocation of the limited budget.

In short, a better allocation of public spending will diminish the impact of the barrier of high fares for public transport, a potential exclusionary factor of the financial dimension, identified in subsection 4.2.4, by helping to reduce prices. In addition MaaS can also diminish another financial barrier, having a low transport budget, because individuals have to spend less in order to have the same mobility (Li & Voege, 2017).

5.3 Existing Ownership-based Transport System toward an Access-based One

In the current transport system a car is the most important privately owned transport modality in the Netherlands representing 75 % of the total distance traveled by the Dutch society (Netherlands Institute for Transport Policy Analysis, 2019). In line with global trends the number of millennials owning a car is decreasing, which can be further reduced by the introduction of MaaS (Mulley, 2017). Therefore, one of the most mentioned impacts of MaaS is probably the “shift away from the existing ownership-based toward an access-based one” (Jittrapirom et al., 2017, p. 13). More specifically, MaaS can contribute to an integrated multimodal system, which implies that the privately owned vehicles will be substituted with alternative on-demand transport modalities (Chowdhury & Ceder, 2016). Lyons et al. (2019) suggested that car ownership might not be essential in order to have the same travel options. Therefore, the Dutch citizens do no longer have to invest in a privately owned car. As a result of the suggested effectively shift demand away from private vehicles, the potential exclusionary factor, car ownership, will be no longer a barrier resulting in reduced accessibility, because a shared car will be available for everyone (Kamargianni et al., 2016). Despite that, some people will still be in favor of their own car due to the fact that some people see the private car as a status symbol for example (Steg, 2003).

In the literature the focus is mainly on car ownership probably due to the relative importance of a car as means of transport and the total costs of ownership. Nevertheless, as a result of the shift from ownership-based transport system toward access-based transport system, the ownership of a bike is also no longer required. In other words, the introduction of MaaS will diminish the access barrier to a car and bike, because as a result of the access-based transport system these transport modalities are available without privately owning one. An individual without a car might be able to use a car on-demand, which results in time savings and an easier journey, represented respectively in the temporal and financial dimension by the access to a car and a bike (Subsection 4.2.2; 4.2.4).

5.4 Improved Accessibility Rural Areas

The transformation of the transport system towards an access-based one does not solely influence ownership of transport modalities, but also the accessibility of the rural areas is expected to increase due to the additional offerings of transport services for rural areas (CIVITAS, 2016). Besides, Smith et al. (2018) concluded that experts foresee that the integrated transport services can function as feeder services to

the offered public transport services. The MaaS providers will use the different public transport options in their offerings in order to offer their customers a broader flora of MaaS offerings. Unfortunately, a side note needs to be made, because during the MaaS congress the attendees suggested that MaaS would not improve the accessibility of the rural areas, because the revenue for the rural areas would not exceed the costs of the offerings of MaaS (MaaS Congress, 2020). However, in this research MaaS of the highest integration level, integrating planning, booking, paying, navigation and information in one digital app, is considered. A MaaS of integration level four is assumed to result in improved accessibility for the rural areas too (Smith et al., 2018).

5.5 Schematic Overview Effects MaaS on Potential Exclusionary Factors

Besides the suggested effects on the potential exclusionary factors, MaaS has other impacts, which are omitted due to the missing relevance for this particular research. In the previous four subsections no impacts were identified affecting one of the potential exclusionary factors of the psychological and physical dimension. The most obvious reason is that MaaS will not change the existing infrastructure of the Dutch transport system, but instead will only use the infrastructure available in the Netherlands to offer their integrated transport services (Sochor et al., 2018). Therefore, the suggested impacts identified in the literature do not focus on the design of the Dutch infrastructure that posing a barrier for an individual. It is only assumed that MaaS will use the existing infrastructure in a more efficient way (Hensher, 2017).

In figure 5.1 the effects of MaaS on the identified potential exclusionary factors on the basis of an extensive literature review are presented. A red line corresponds with a deepening effect on the particular potential exclusionary factor, while a green line represents a diminishing effect on the connected potential exclusionary factor. Every line represents a hypothesis on the basis of the reviewed literature. A deepening effect of a potential exclusionary effect is considered to lead to a higher risk on transport related social exclusion, while a diminishing effect will result in a lower risk on transport related social exclusion, merely transport related social inclusion. These hypotheses, displayed in table 5.1, are formulated in order to be tested in the next chapter, chapter 6, by conducting in depth-interviews.

Table 5.1: The effects of MaaS on transport related social exclusion derived from literature

Suggested impact in literature	Diminishing effect	Deepening effect	Explanation
<i>Digitalization</i>		No internet access	<i>Subsection 5.3</i>
	No digital information	Difficulties to access digital information	
<i>Affordable mobility</i>	High fares public transport		<i>Subsection 5.2</i>
	High total costs of ownership transport modalities		
<i>Access-based transport system</i>	No access to a car		<i>Subsection 5.4</i>
	No access to a bike		
<i>Improved offerings rural areas</i>	Long travel time		<i>Subsection 5.4</i>
	Low Frequency PT		
	No PT at certain parts of the day		

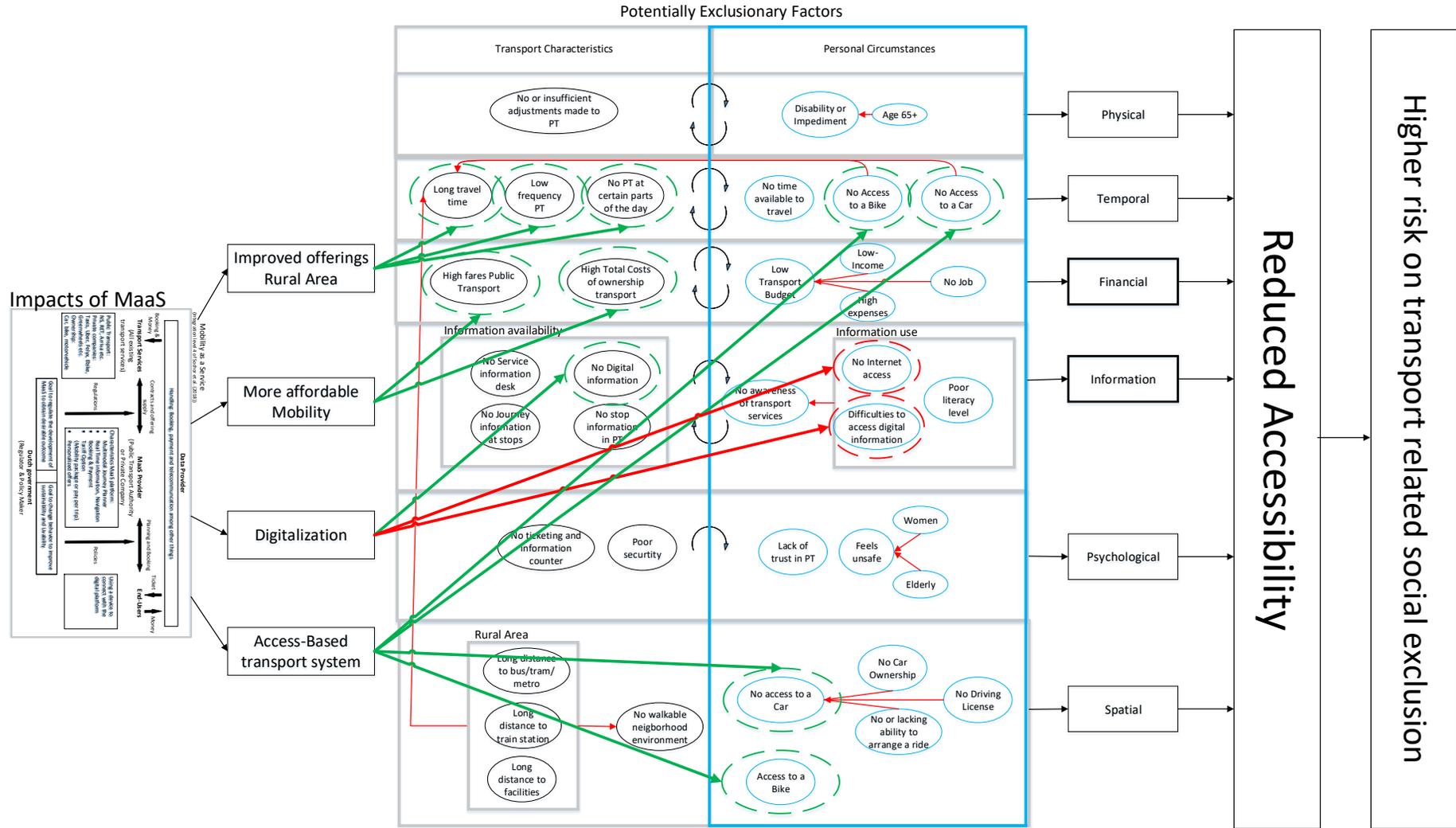


Figure 5.1: The effects of MaaS on the potential exclusionary factors based on literature

6. Adjustments and Additions to Conceptual Framework

In the previous three chapters the framework representing the effects of MaaS on transport related social exclusion was conceptualized. This framework was conceptualized on the basis of an extensive literature review. The literature review resulted in nine effects suggesting that the introduction of MaaS may result in transport related social inclusion, diminishing eight potential exclusionary barriers, while only two effects may result in transport related social exclusion, deepening two potential exclusionary barriers. This is in contrast with the suggestion of Pangbourne et al. (2018), who emphasized the potential social inequity as a result of the introduction of MaaS. Therefore, semi-structured interviews were conducted in order to gather primary data about the effects of MaaS on transport related social exclusion. The coding results are discussed in subsection 6.1. Hereafter, the negative effects of MaaS on the inclusivity of the Dutch transport system suggested by the interviewees are presented in subsection 6.2, while the positive effects derived from the literature are reviewed on the basis of the data obtained through the semi-structured interviews in subsection 6.3. The adjustments and additions suggested in subsection 6.2 and 6.3 are applied to the conceptual framework in subsection 6.4. In the last subsection 6.5 the obtained differences between the primary data, interviews, and the secondary data, literature, are explained by pointing out the underlying assumptions.

6.1 Results of the Semi-Structured Interviews

A total of seven in-depth semi-structured interviews were conducted. The group of interviewees consist of six experts and one experience expert. The interviewees are considered an expert for this research due to the fact of their expertise in either one or both of the key concepts of this research, Mobility as a Service and transport related social exclusion (Appendix B: Table B.1). The interviewee is considered an experience expert, because the anonymous interviewee has a higher risk on transport related social exclusion and belongs to the vulnerable group of elderly people. For every interview, questions were selected from the list of possible interview questions due to time constraints (Appendix B). The majority of the interviews were conducted by phone. Only for the interview with Jaap Sytsma Microsoft Teams was used. All interviews were audio recorded, facilitating the process of making a transcript of every interview afterwards. Two of the experts –Meerbach and Sytsma – are actively engaged in MaaS either developing MaaS or doing executing research about MaaS, while three experts – Van der Bijl, Hughes and Kampert – have researched the transport related social exclusion concept. One of the six experts – Anne Durand – have researched both of the key concepts, Mobility as a Service and transport related social exclusion.

The interviews resulted in 66 unique codes that were related to 6 themes. Astrid Kampert and the individual with a higher risk on transport related social exclusion, referred to as anonymous interviewee in this research, talked about respectively three and four of the six themes only, while the other five interviewees mentioned at least one code of every identified theme (Appendix D: Table D.1).

The reason for the little contribution of Astrid Kampert, 10 unique codes, was that Astrid Kampert was only allowed to discuss the two studies about transport related social exclusion (Kampert interview, 20th April 2020). Therefore, she was not able to discuss the potential of MaaS on transport related social exclusion. The anonymous interviewee mentioned eighteen unique codes, because the individual lacks specific knowledge of one of the key concepts. Nevertheless, the individual provided interesting information about the effects of MaaS for one of the vulnerable groups, the elderly.

The anonymous interviewee contributed to the empirical evidence for this research as an experience expert. Nonetheless, the anonymous interviewee only mentioned four unique codes, which emphasizes the fact that only one experience expert was interviewed due to the little extra contribution in terms of data. On top of that, as a result of the corona pandemic it was difficult to contact individuals with a high risk on transport related social exclusion by email which requires certain digital skills.

In figure 6.1 the saturation of the gathered data sample is presented. From this overview it can be concluded that the sample has no full saturation. This implies that extra interviews can still uncover new codes and thus for example potential effects of MaaS on the inclusivity of the Dutch transport system or potential policies to mitigate the threats of the introduction of MaaS. Therefore most probably not all the codes are uncovered, which implies no full saturation (O'Reilly & Parker, 2012). Nevertheless, it can also be concluded that the amount of unique emerging codes decreased for every extra interview. For that reason taking into account the limited time, the sampling was stopped after the seventh interview, resulting in only four new unique codes. The data are used in order to define the effects of MaaS on transport related social exclusion in the next two subsections and to recommend the government in the next chapter on how to steer the development of MaaS. However, conclusions need to be drawn with great caution, because MaaS is still in its infancy and for that reason it is difficult to predict the exact development of MaaS (Van der Bijl interview, 22nd April 2020).

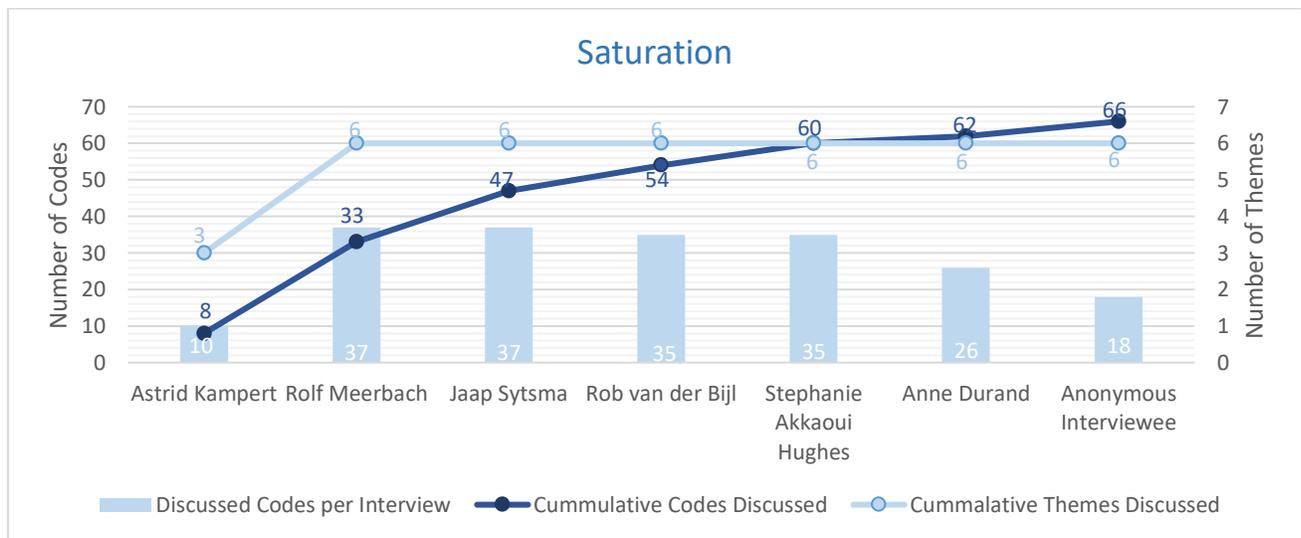


Figure 6.1: Saturation of the Interviews

6.2 Effects of MaaS Potentially Resulting in Reduced Accessibility

Almost all the interviewees pointed out that several potential exclusionary factors can result in inadequate participation referred to as transport related social exclusion. Unfortunately an adequate solution does not exist for all the different vulnerable groups (Sytsma interview, 22nd April 2020). The interviewees were less optimistic than the reviewed literature in chapter 5. The interviewees mentioned three potential negative impacts on the inclusivity of the Dutch transport system as a result of the introduction of MaaS, in contrast to the reviewed literature that mentioned only one. First of all it was repeatedly suggested that certain groups in the society lack the ability to use a digital app. This matches with the only negative effect of MaaS derived from the literature. Six out of the seven interviewees pointed out that the digitalization of the transport system as a result of the introduction of MaaS will pose a barrier resulting in a higher risk

on transport related social exclusion (Appendix D). The groups within the population – regardless of age – that just cannot keep up with the digitalization and that have a phone that is not able to run the newest applications should not be underestimated (Van der Bijl interview, 22nd April 2020). Some people lack the ability to use the digital MaaS app, which prevents them from using the MaaS app and thus using the available transport offers.

The other two negative effects of MaaS on the potential exclusionary factors that were revealed by the interviews are the claim that MaaS has an effect on the lack of trust of certain groups has with the data dependent digital app (this is further explained in subsection 6.2.1), and the suggestion that MaaS poses a greater financial barrier than the traditional system (this is further explained in subsection 6.2.2). The latter suggestion is contradictory to the suggestion derived from the literature that MaaS makes transport cheaper.

6.2.1 Certain Groups Lack Trust in a Data Dependent Digital App

An aspect of MaaS that potentially results in transport related social exclusion is that some people lack trust in a data dependent digital app. Even though the individual was aware of all the data that was collected about the individual, the individual with a higher risk on transport related social exclusion concluded that it scared her and her elderly peers (Anonymous interview, 24th April 2020). Anne Durand added to this that as a result of the privacy issues regarding the Corona virus app people become more aware of the privacy issues. Trust issues might be deepened as a result of the introduction of MaaS, because people have to put in extra information such as a credit card to make use of the digital MaaS app, which by some people is considered as losing control over the situation (Hughes interview, 23rd April 2020). Most people will take the conditions of MaaS for granted, but for a minority it is a hurdle that is difficult to overcome by just telling it is safe to put money on a digital bank balance of the MaaS provider (Hughes interview, 23rd April 2020).

6.2.2 MaaS Poses a Greater Financial Barrier Opposed to the Existing System

The review of the available literature and documents suggested that MaaS will result in cheaper transport. However, implemented mobility solutions similar to MaaS scored poorly on financial aspects (Van der Bijl interview, 22nd April 2020). Besides, a shared car or shared bike are not necessarily cheaper than a private car or bike (Sytsma interview, 22nd April 2020). Even though the ambition of MaaS is to offer the cheapest travel option, this offer will not necessarily be the cheapest option to travel from A to B (Hughes interview, 23rd April 2020). For example to make use of the MaaS service a monthly payment might be required. For people that do not travel enough to justify the monthly payment, the offered cheapest option is not the cheapest option for them. This example especially applies to the less mobile people, who in general have a higher risk on transport related social exclusion. Therefore, it is assumed that MaaS at an early stage will not result in cheaper transport, on the contrary it will result in more expensive transport and thus present a more difficult barrier to overcome for some segments of the Dutch population. The intermediary, MaaS provider, has to make profit, which in the early stage must be paid for by the end-users. In a later phase MaaS might result in cheaper transport due to the bulk negotiations suggested in the literature, but the development of MaaS is extremely uncertain and thus the effect at the early stage must be accepted.

6.3 Effects of MaaS Potentially Resulting in Increased Accessibility

Unless the fact that the positive effect of MaaS, cheaper mobility, is refuted, three other positive impacts were suggested. There is agreement between the literature and the conducted interviews about the improved information provision as a result of the introduction of MaaS. The availability of transport will

not increase as a result of MaaS, but as a result of an organized and insightful MaaS app the end-user will be better informed about the available transport options (Meerbach interview, 21st April 2020). If all the existing transport options and related information is available in one app, the end-user will acquire improved digital information provision (Durand interview, 23rd April 2020).

Besides, even though the access to a car will improve according to the interviewees, the access to a car for the vulnerable groups will not improve, because only certain groups profit, which is discussed in subsection 6.3.1. The suggested improvement of the offers in the rural areas in the literature is questioned by the interviewees in subsection 6.3.2.

6.3.1 Mobile Population Profits from Access-Based Transport System

The intention of MaaS is to change the existing transport system towards an access-based transport system (Durand, 23rd April 2020). The introduction of MaaS will definitely stimulate the sharing economy (Meerbach, 21st April 2020). Nevertheless, the shared car will only be available for the specific group that can afford the shared car. The population that is already mobile will profit from the fact that they are aware of the available transport options near their location, because they are the ones that can afford it (Sytsma, 22nd April 2020). The millennials that have adequate transport budgets, but decide to not invest in a private car yet, will benefit from the introduction of MaaS regarding the access-based aspect instead of the vulnerable groups due to the fact that the financial burdens of a shared car might even be higher (Anonymous interview, 24th April 2020).

6.3.2 Governance Required in order to obtain Improved Offerings for Rural Areas

In the literature the suggestion was made that the introduction will result in improved offerings in rural areas. However, all the interviewees assumed that commercial parties will become the MaaS service provider and that the commercial parties will only care about their profits (Van der Bijl interview, 22nd April 2020). Therefore, the MaaS providers will focus on the urban areas due to the amount of customers within this area, which implies that travel options for the rural areas will not increase. However, MaaS has the potential to improve the offers in the rural areas even though the lower density of people implicates less profit for the commercial MaaS service provider (Durand interview, 23rd April 2020). In order to obtain improved offerings for rural areas the Dutch government has to steer the development of MaaS discussed in the next chapter (Van der Bijl interview, 22nd April 2020).

6.4 Adjusted Conceptual Framework on the basis of the Conducted Interviews

It can be concluded from the previous two subsections that interviewees agree with some of the suggested effects of MaaS in the reviewed literature. Both the interviewees and the literature suggested that the digitalization of the transport system as a result of MaaS on the one hand results in more organized and insightful digital information diminishing one potential exclusionary barrier “no digital information”. On the other hand digitalization results in deepening of two potential exclusionary factors related to the resources and abilities to access the digital MaaS platform (Table 6.1). Besides, another negative effect of the digitalization as a result of the introduction of MaaS was derived from the interviews. A certain trust in the MaaS platform is required, which might deepen the psychological potential exclusionary barrier “lack of trust” (Table 6.2) (Figure: 6.2).

Next to the agreements and additions to the conceptual framework, the interviewees were less optimistic about the other suggested impacts in the reviewed literature and documents in chapter 5. First of all, the effect of MaaS resulting in cheaper transport is adjusted on basis of the expertise of the interviewees. It

was suggested that MaaS will result in more expensive transport at the early stage, while the more affordable transport as a result of negotiation is only conceivable at a later stage (Table 6.3). Thus, the positive impact of cheaper transport is replaced by the effect of deepening the barrier of high fares public transport (Figure: 6.2). Furthermore, the improvement of rural areas was considered a potential effect of MaaS in the reviewed literature. However, offering of the rural areas will only improve if the Dutch government steers the development of MaaS, expressed with green dotted lines in the conceptual framework (Figure: 6.2). At last the effect of an access-based transport system is under discussion. Even though the interviewees agreed that the access-based transport system provides easier access to a car and bike, the access to the shared car is considered to be of most value for the mobile population instead of removing a barrier for the people that have a higher risk on transport related social exclusion (Table 6.3). The main reason is that people cannot afford the shared transport modalities even though they are available. Therefore, the effects of this impact are displayed in black to show that they will not remove barriers for the transport related socially excluded people (Figure 6.2).

Table 6.1: Agreement of effects of MaaS among reviewed literature and conducted interviews

Impact	Diminishing effect	Deepening effect	Explanation
<i>Digitalization</i>		No internet access	<i>Subsection 5.3</i>
	No digital information		
		Difficulties to access digital information	

Table 6.2: Suggested additional effects of MaaS by the interviewees

Impact	Diminishing effect	Deepening effect	Explanation
<i>More expensive public transport</i>		High fares public transport	<i>Subsection 6.2.2</i>
<i>Digitalization</i>		Lack of trust in public transport	<i>Subsection 6.2.1</i>

Table 6.3: Disagreement of effects of MaaS among reviewed literature and conducted interviews

Impact	Diminishing effect	Deepening effect	Explanation
<i>Affordable mobility</i>	High fares public transport		<i>Only realistic in later stage of MaaS. Subsection 6.2.2</i>
	High total costs of ownership transport modalities		
<i>Access-based transport system</i>	No access to a car		<i>Only already mobile population profit from this impact. Subsection 6.3.1</i>
	No access to a bike		
<i>Improved offerings rural areas</i>	Long travel time		<i>Only achievable with effective steering of government. Subsection 6.3.2</i>
	Low Frequency PT		
	No PT at certain parts of the day		

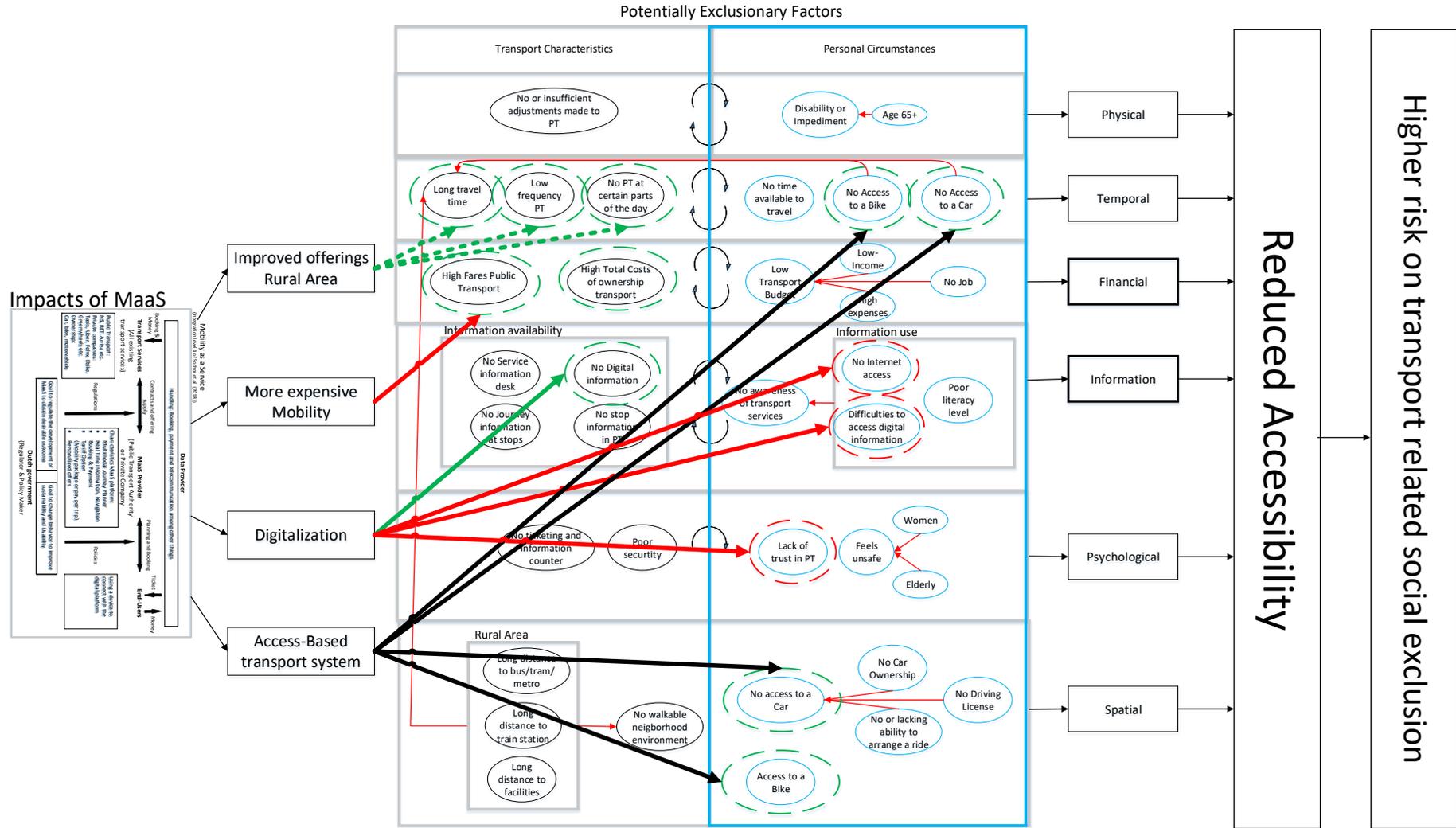


Figure 6.2: The effects of MaaS on potential exclusionary factors based on literature and interviews

6.5 Underlying Assumptions of Interviews and Reviewed Literature

It is relevant to realize that the suggested effects of MaaS are based on different underlying assumptions. The introduction of a successful MaaS application will result in economies of scale according to the reviewed literature (Mulley, 2017). The costs per unit will decrease with increasing scale. Since it is suggested in the literature that the introduction of MaaS will increase the overall mobility, the total output will increase over time enabling economies of scale. Through the economies of scale the decreasing costs per trip will be passed on to the end-users, resulting in lower costs for mobility. Thus, the reviewed literature suggested more affordable mobility as a result of the introduction of MaaS by implicating economies of scale of the transport system. However, the interviewees doubt this assumption. They suggest that the introduction of MaaS will cause more expensive mobility at the early stage. They even have the underlying assumption that an intermediary – the MaaS provider – will structurally result in increased costs anyhow.

Besides, it is assumed a MaaS app will enclose all the existing transport companies (MaaS, 2019a). The reviewed literature has the underlying assumption that all the existing transport companies will be enclosed in the future MaaS service as a result of the economies of scale. This is explained by the fact that if a transport company is not integrated in the MaaS service, the transport company will lose customers and generate less profit. However, this assumption was also doubted by the interviewees due to the missing incentive for the major (public) transport companies to take part in MaaS. The major transport companies might not be willing to cooperate with new transport companies and offering them a piece of the pie, the total executed trips by the Dutch population (Anonymously interview, 24th April 2020).

The underlying assumptions in the reviewed literature can be described as ambitions of MaaS. Due to the complexity of the implementation of MaaS, time will tell whether the underlying assumptions in the reviewed literature, ambitions of a successful implementation of MaaS, will be achieved (Durand interview, 23rd April 2020). It needs to be emphasized that the experts of both MaaS and transport related social exclusion are not convinced that the underlying assumptions of the reviewed literature are realistic and attainable.

Using the Framework

The conceptual framework on the basis of both semi-structured interviews and literature review is used to formulate recommendations for the Dutch government. The recommendations for the government's role and conditions of an inclusive MaaS are on the basis of the in-depth semi-structured interviews and substantiated with document analysis.

7. Ideas for Policy

The conceptual framework provides insight in the effects of MaaS on transport related social exclusion. In order to ensure the inclusiveness of the Dutch transport system the Dutch government has to steer the development of MaaS. As discussed in section 3.2 the government can take on different roles. In the in-depth interviews the role of the government and the conditions of MaaS in order to improve the inclusiveness of the Dutch transport system were discussed. In this chapter the information gathered through the semi-structured interviews was used to develop ideas for policy, an exploratory advice for the Dutch government. The interviewees agreed on the fact that the Dutch government should actively steer the development of MaaS as legislator and regulator, which is emphasized in detail in subsection 7.1. Hereafter in subsection 7.2, the proposed conditions offering the highest level of MaaS for as many people as possible are presented.

7.1 Role of the Government

One of the goals of the Dutch government is to ensure mobility for everyone (Ministry of Infrastructure and Water Management, 2019). Therefore it can be emphasized that regulation of the development of MaaS is essential in order to guarantee inclusivity (Van der Bijl interview, 22nd April 2020). There was consensus among the interviewees about the fact that the Dutch government should not control a MaaS platform herself. At the moment the government is actively taking part in the development of MaaS with the seven MaaS pilots. One of the reasons for this is to avoid venture capitalists or other commercial parties to rule the implementation of MaaS while only focusing on profit and neglecting the inclusiveness of the Dutch transport system.

The Dutch government has to steer the development of MaaS in order to obtain desirable societal outcomes such as an inclusive transport system (Meerbach interview, 21st April 2020). Therefore, a role as regulator and legislator is suggested. The government must determine the rules and conditions within which the transport services and MaaS provider have to develop MaaS (Durand interview, 23rd April 2020). Before the introduction of MaaS and during the further developments of MaaS, the debate on social and moral issues regarding the introduction of MaaS must be conducted (Van der Bijl interview, 22nd April 2020). The role as regulator and legislator should be on ensuring a certain level of accessibility for everyone, improving the livability of the urban area and creating a level playing field.

7.2 Conditions for a more Inclusive MaaS

The Dutch government should encourage and actively steer the development of MaaS as legislator and regulator, due to the suggested great potential of MaaS to meet the Dutch citizen's mobility needs. In the interviews a number of potential conditions that can be set in order to improve the inclusivity of the transport system were suggested. All these conditions require a certain investment of the Dutch government in terms of time and money. The importance of money regarding the inclusivity of the transport system was pointed out during the interviews:

“If you had an unlimited budget, then of course many personal circumstances that hinder an individual could be countered, but unfortunately there is no unlimited budget.” (Kampert interview, 20th April 2020)

The government has to include as many people as possible. In order to do so, the interviewees suggested several conditions for an inclusive MaaS. In the next five subsections, five suggested conditions that should

be met using regulations or legislations in order to improve the inclusivity of the transport system given that MaaS will be implemented, are presented.

7.2.1 Create a level playing field

The government should create a level playing field for both the MaaS providers and the transport operators (Van der Bijl interview, 22nd April 2020). The commercial parties mainly focus on profits. For that reason a market supervisor is essential to safeguard the inclusivity of the Dutch transport system. On the one hand, with the help of issuing subsidized concessions, the Dutch government provides a certain level of accessibility for every Dutch citizen (Sytsma interview, 22nd April 2020). On the other hand, the Dutch government has to provide equal opportunities for market entrants. Ideally, the competition of commercial parties ought to result in improved mobility services for all Dutch citizens (Spithorst, 2014).

Mobility is a cornerstone of society and should not be seen as consumption good (Van der Bijl interview, 22nd April 2020). The public utilities should not be eroded as a result of commercial on-demand platforms. The introduction of transport network companies such as Uber resulted in increased congestion (Erhardt et al., 2019). The government has limited regulations for these relatively new transport network companies. Consequently, these companies do not have to abide by the strict regulations of traditional taxi companies (Van Dijk, 2019). The government has to prevent that the Dutch cities will be overfilled with shared cars, scooters and steps (Sytsma interview, 22nd April 2020).

7.2.2 Align Goals

Before thinking about implementing MaaS, the debate should be about whether the introduction of MaaS has societal value or not regarding the inclusiveness of the transport system among other things (Van der Bijl interview, 22nd April 2020). Indeed, it is of great importance that the goals of the government, transport providers, transport services and the end-users are aligned in order to ensure that as many people as possible are able to meet their mobility needs:

“The communication should be aligned, because otherwise you will have a dead conversation. If you are not aligned people can’t really reach consensus on a topic, because they are talking about different things. If you know that in a certain area people are really concerned about their health. Then instead of prospering CO2 reduction and trying to change their choice of transport modes regarding sustainability, the policy makers should start talking about boosting the neighborhoods choices in a healthy way.” (Hughes interview, 23rd April 2020)

Therefore, it is essential to uncover the needs of the end-users. As a result of Covid-19 pandemic people may value a healthy journey in terms of risk on infection higher than a journey with the lowest costs. If the MaaS provider and the government are aware of the most important criteria for the end-users, they will be able to adjust the offerings and the design of the MaaS app in such a way the end-user realizes the advantages of the MaaS app in order to fulfill their personal mobility needs (Bosse et al., 2005). Of course, if the personal preferences of the end-user are taken into account, the goals of the government such as sustainability can be integrated in the offers already including the most important criteria of the end-user. An example of a regulation measure is that a shared car provider is only allowed to place cars in the urban area in the case the shared car provider also offers shared cars in the rural areas (Sytsma interview, 22nd April 2020). The transport services and MaaS provider will accept this regulation, if the profits they make in the urban area exceed the losses they make in the rural areas. Besides, the government can subsidize

the offerings in rural areas to make up for the losses. This particular regulation will increase the offerings for the residents of the rural areas and thus improve the accessibility of the rural areas. Aligning the goals of the four actors' - the Dutch government, MaaS provider, transport services and end-users - interests might offer full advantage of the opportunity MaaS delivers to diminish potential exclusionary factors related to the poor accessibility of the rural areas by increased offerings in rural areas as a result of the suggested regulation.

7.2.3 Use Data to Improve Dutch Mobility Policy

MaaS ensures that a lot of data becomes available about the travel behavior of the end-users of MaaS. The privacy of their citizens regarding the data dependent app should be ensured by European legislation. Moreover, the Dutch government might take full advantage of the available data:

"It would be great if the government becomes the learning center. A lot of data will be available as a result of MaaS, which can be used to research travel behavior. It would be great if all these data can actually be collected and researched holistically. We would be able to learn much faster." (Hughes interview, 23rd April 2020)

As a result of the available data the Dutch government's knowledge about an individual's travel behavior might provide useful information about whether the individual is unable to participate in the society due to posed barriers. If the Dutch government learns from the available data, the government may be able to introduce personal mobility budgets for people that cannot afford necessary mobility to adequately participate in society (Sytsma interview, 22nd April 2020). However, for these personal mobility budgets "sufficient information on the number of customers and their mobility needs would be required for organizing and procuring the services" (Eckhardt et al., 2018, p. 82). For example, if an individual is able to make use of public transport as part of his or her journey instead of making a complete trip with a subsidized taxi, the introduction of MaaS will result in public savings (Meerbach interview, 21st April 2020). As a result of the available data, the government might be able to improve the Dutch Mobility policy. Therefore, a centrally arranged learning center of the government might be crucial in order to successfully allocate governmental budget for personal mobility budgets for people that experience financial barriers.

7.2.4 Adjustments to Digital Platform

As stressed out in the previous two chapters some people lack abilities or resources to access the digital platform of MaaS. For the success of MaaS it is important that the digital platform is simple and that in case a customer needs help it is offered in a user-friendly, convenient way:

"I know from my own experience that it is really hard to contact digital platform 9292. The helpline referred me repeatedly to the website of 9292 with FAQ's. The helpline should be designed in order to assist people unable to consult the digital platforms on their own." (Anonymous interview, 24th April 2020)

Digital platforms nowadays assume certain digital users' skills. However, the amount of people that have difficulties must not be underestimated (Ministry of the Interior and Kingdom Relations, 2018). A call service needs to be integrated in such a way that it ensures people lacking digital skills to be able to plan, book and pay for their journey (Meerbach interview, 21st April 2020). Besides, the MaaS app should be designed with the purpose to include people with impairments and impediments. The NS for example,

included screen reading and the option to order travel assistance in their digital app (NS, 2020). It is essential that these functions are included in newly developed apps in order to prevent people from not using MaaS due to the design of the app.

7.2.5 Traditional Transport System

The conditions in the previous three subsections focused on the conditions of MaaS. Nevertheless, it was pointed out that a transport system that is completely dependent on MaaS is not desirable:

“I definitely think that the traditional system of the ‘OV Chip card’ should remain operational. At least for the coming decades in order to ensure the inclusivity of the Dutch transport system.” (Anonymous interview, 24th April 2020)

The interviewee with a higher risk on transport related social exclusion stressed the size of the population that will not be able to make use of either MaaS as it is suggested in the literature or MaaS with the proposed conditions. The government should prevent that the gap between people with high accessibility and people with low accessibility increases (Durand interview, 23rd April 2020). In order to make sure the introduction of MaaS does not result in a greater gap, the traditional transport system should stay operational for at least the coming decades. Even though MaaS has great potential for the largest group of the population, mobility should be assessed as a public good rather than a consumer good from a governmental perspective.

Conclusions of the Research

The conclusions of the research are presented alongside the limitations of the executed research. The conclusions and limitations are used to formulate potential powerful future research.

8. Conclusions and Discussion

In this last chapter the main conclusions and limitations of this research will be discussed in respectively subsection 8.1 and subsection 8.2. The main conclusions are derived from the findings of the conducted research and are used to answer the research question. In the third and last subsection, 8.3, suggested further research on basis of the main conclusions and limitations of this research are presented.

8.1 Conclusions of the Research

The goal of this research was to explore the effects of the innovative mobility concept Mobility as a Service on the inclusivity of the transport system and by that filling the existing knowledge gap. The introduction of Mobility as a Service can improve the offers of mobility for the Dutch citizens. However, Pangbourne et al. (2018) suggested that the introduction might deepen exclusion by over digitalizing and enclosing access to the existing transport services. In this research the effects of MaaS on transport related social exclusion were analyzed using an exploratory research approach to answer the research questions formulated in the introduction of this research:

- 1) To what extent will the introduction of Mobility as a Service result in transport related social exclusion?*
- 2) How could the government steer the development of Mobility as a Service in order to overcome transport related social exclusion?*

The research resulted in a conceptual framework showing all potential diminishing and deepening effects of MaaS on the potential exclusionary factors influencing the risk on transport related social exclusion. The MaaS optimists are certain about the positive effects of MaaS for the end-users of MaaS. The general public will most probably experience these foretold positive effects. However, several vulnerable groups within the Dutch population will encounter certain barriers that might prevent them from accessing the MaaS platform. There is a clear risk that poorly designed MaaS platforms will result in an increase in social inequity. Therefore, it was concluded that the development of MaaS requires further attention in order to obtain desirable societal outcomes, namely transport related social inclusion: the process that an individual is able to participate in society up to the society's standard by means of sufficient accessibility.

Effects of MaaS on transport related social exclusion

For this research, MaaS is considered as being a digital platform offering multi-modal personalized travel options that can be planned, booked and paid, while receiving real-time information and navigation. The MaaS platform of the highest integration level is considered to have four impacts resulting in as well deepening as diminishing of potential exclusionary factors. These potential exclusionary factors affect an individual's accessibility, which influences the risk on transport related social exclusion. In table 8.1 the suggested impacts on the potential exclusionary factors are displayed. These effects of MaaS are derived from the reviewed literature and by the conducted semi-structured interviews. However, with the current state of knowledge it is impossible to definite on the effects of MaaS on transport related social exclusion, because debate is still going on about what is exactly understood by MaaS, who will be the MaaS provider and what will be the design of the digital MaaS app. It can be concluded that the interviewees were less optimistic about the impacts of MaaS on transport related social exclusion. The positive impacts were either refuted or doubted resulting in adjustments to the final conceptual framework. The differences in

suggested effects are a result of the differences in underlying assumptions. Eventually, it is concluded that a poorly designed MaaS platform will result in transport related social exclusion. From that, the second research question was formulated to develop certain conditions to mitigate the plausible deepening effects and take full advantage of the opportunities of the introduction of MaaS.

Table 8.1: Effects of MaaS on transport related social exclusion

Impact	Literature or Interviews	Diminishing or Deepening effect	Substantiation whether the impact is considered plausible to have an effect on one or more of the uncovered potential exclusionary factors.
Digitalization	<i>Both</i>	<i>Predominantly Deepening effects</i>	Plausible <i>A significant part of the population lacks the resources and ability to access this digital MaaS platform. Even though, this digitalization of the transport system will improve the digital information provision, it will deepen the barriers for individuals lacking digital skills and a working smartphone. Moreover, end-users have to fill in personal information such as their credit card details, which requires an amount of trust in the digital platform posing barrier to make use of this new mobility concept.</i>
More expensive mobility	<i>Interviews</i>	<i>Deepening effects</i>	Plausible <i>MaaS at an early stage will result in increased costs, because an intermediary, the MaaS provider, has to make profit at the start. Thus, at the early stage the introduction of MaaS will have a deepening effect on the potential exclusionary factor of the financial dimension resulting in reduced accessibility for the population without adequate financial resources.</i>
Affordable mobility	<i>Literature</i>	<i>Diminishing effects</i>	Implausible <i>Only at a later stage the suggested negotiation in the literature about prices as a result of the purchase of bulk trips might lead to reduced costs.</i>
Improved offerings rural areas	<i>Literature</i>	<i>Diminishing effects</i>	Plausible subject to effective governance <i>In the literature MaaS was suggested to have a positive effect on the offerings of rural areas. Nevertheless, the interviewees indicated that governance is essential in order to achieve this positive effect due to the fact that the MaaS provider's primary interest lies in the profits, which are suggested to be lower or even loss-making in the low-density areas.</i>
Access-based transport system	<i>Literature</i>	<i>Diminishing effects</i>	Plausible subject to costs of shared cars <i>MaaS will reduce car ownership and replace it with shared cars or other mobility options. However, the costs of a shared car are relatively high, which implicates that only the people with sufficient transport budget can afford a shared car. Therefore, the change from an ownership-based transport towards an access-based one will be most probably beneficial for the part of the population that already has sufficient accessibility to participate in the Dutch society instead of improved access to a car for the individuals with a higher risk on transport related social exclusion.</i>

The government as legislator and regulator

Using the information of the first research question – the conceptual framework consisting of the effects of MaaS on transport related social exclusion –, the second research question was answered. Even though there is some uncertainty regarding the outcomes of this research, the exploration of the effects can be used to advise the Dutch government on how to steer the development of MaaS. All the interviewees agreed on the fact that the government should actively steer the development of MaaS as legislator and regulator. The interviewees formulated the following policy ideas:

- Create a level playing field for the actors in the core business of MaaS – transport operators, MaaS providers and Data provider.
 - The regulations need to be the same for example for traditional taxis and transport network companies.
- Use the extra available data delivered by MaaS to improve Dutch mobility policy
 - A learning center making it possible to learn from Dutch citizens' travel behavior
- Align goals of core actors of MaaS and the government in order to obtain desirable outcomes
 - For example a shared car service is only allowed to place their cars in urban areas, if the company will also place a certain number of cars in rural areas.
- Adjust design of digital platforms in order to ensure access for as many people as possible
 - For example making a call service mandatory for every MaaS platform in order to help people with difficulties in accessing digital platforms.
- Keep the traditional transport system operational
 - 2.5 million People encounter difficulties with the digitalization in the Dutch society (Ministry of the Interior and Kingdom Relations, 2018). For all these people the traditional system – OV chip card for example – is needed to meet their mobility needs.

Discussion on conclusions

The only impact on the potential exclusionary factors that is mentioned both in the literature and by all the interviewees is the digitalization of the existing transport system. It is believed by the author that the digitalization of the transport system is inevitable. Even though MaaS might not be implemented, the digitalization of the transport sector will still pose certain barriers for a significant part of the population. Therefore, it is of great importance to start the debate about the social and moral impacts of the introduction of a new mobility concept in order to prevent an increase of social inequity in the transport sector.

8.2 Limitations of the Research

The aim of this research was to develop “understanding of the effects of the introduction of Mobility as a Service on the inclusiveness of the Dutch transport system”. Even though this research did not result in a complete understanding of the effects of MaaS on transport related social exclusion, the gathered information is believed to provide a better general understanding of the diminishing and deepening effects of MaaS regarding the inclusiveness of the Dutch transport system. The results of this research are useful for Dutch policy makers by including certain steering policies to maintain or improve the inclusiveness of the transport system. Nevertheless, there are some clear limitations to this study. First of all, the coronavirus Covid-19 pandemic complicated the research, which will be discussed in subsection 8.2.1. Hereafter, limitations of the chosen research methodology will be discussed in subsection 8.2.2. In subsection 8.2.3 the limitations regarding the complex research area will be discussed, which resulted in a simplistic static conceptual framework that is unable to cover the complexity of the real world discussed in the last subsection, 8.2.4.

8.2.1 Coronavirus Changed the Group of Interviewees

The corona pandemic resulted in a so-called intelligent lockdown at March 12th, 2020. The intelligent lockdown resulted in some adjustments for this research during the process. The intelligent lockdown made it impossible to interview elderly with a higher risk on transport related social exclusion, because the researcher was not allowed to visit the elderly. The impacts of the introduction of MaaS for the elderly are mainly focusing on the digitalization of the Dutch transport system. Therefore, it was impossible to interview the elderly with difficulties regarding digitalization, because digital platforms were the only method left to interview people.

For that reason the group of interviewees changed from elderly with a high risk on transport related social exclusion into experts about transport related social exclusion or Mobility as a Service and digitally skilled elderly with knowledge about their peers having difficulties with the digitalization. So, the group of interviewees changed, which resulted in a group of interviewees with specific knowledge about both key concepts instead of a mix with both experts and a representative group of potential transport related socially excluded people. Clearly the potential socially excluded people would have contributed to an empirically stronger evidence of the effects of MaaS on transport related social exclusion.

8.2.2 Exploratory Research Approach

The research provides insights in what all potential diminishing and deepening effects of MaaS on the potential exclusionary factors influencing the risk on transport related social exclusion are, but these insights are based on an exploratory analysis. Just like all research approaches, the exploratory research approach has its limitations. The major limitation of the exploratory approach is that qualitative information is used, which is most probably subject to bias. Due to the relatively new mobility concept, MaaS, the literature and empirical data on this key concept are limited.

Therefore, besides extensive literature reviewing, experts were consulted to validate the proposed framework. The consultation of experts resulted in new insights about the effects of MaaS on potential exclusionary factors even though the experts formulated their statements carefully due to the novelty of the topic. Due to the novelty of the topic some statements are based on personal opinions, which was emphasized multiple times by the interviewees. Therefore, some biased statements might be included in the report.

8.2.3 Complexity of the Research Area

As pointed out before, both of the key concepts of this research, MaaS and transport related social exclusion, are considered complex concepts, which was emphasized in chapter 3 presenting the lack of consensus about the exact definition of both of the concepts. Furthermore, MaaS has not been implemented in the Dutch society yet, which complicated the analysis of the potential effects of the introduction of MaaS. The potentially exclusionary factors resulting in transport related social exclusion are part of a more complex system than could be captured in this research within the 21 weeks and methods used in this research.

8.2.4 Static and Simplistic Conceptual Framework

The proposed conceptual framework is unable to capture the real world complexity due to the lack of knowledge about the implications of MaaS among other things. Besides, the conceptual framework did not take into account the dynamic and relational nature of the exclusionary process (Kenyon, 2003). On top of that the wide range of local and non-local processes are not all captured in the conceptual

framework. Moreover, the factors proposed in the framework are displayed as binary factors, while in the real world the same factors might cover multiple underlying factors or are characterized by myriad gradations (Schwanen et al., 2015). However, the conceptual framework provides insight for the policy makers and fills the identified knowledge gap within the current state-of-knowledge.

8.3 Further Research

Despite the limitations, this research provides insight in the potential effects of MaaS on potentially exclusionary factors resulting in reduced accessibility. As a result of the limitations of this research three recommendations for further research are discussed in the next three subsections.

8.3.1 Quantify effects of MaaS on transport related socially excluded population

The research provided qualitative results whilst it is of great importance for the Dutch policy makers to steer the development of MaaS on the basis of quantitative data. The size of the different groups that encounter the same barrier needs to be examined in order to make an informed decision whether to invest in a certain adjustment or addition for the MaaS platform, because the budget of the Dutch government is limited (Kampert interview, 20th April 2020). If the Dutch government is aware of the amount of people that encounter a barrier as a result of the introduction of MaaS, the Dutch government can make a better informed trade-off between their budget and the inclusiveness of the Dutch transport system.

As pointed out in the research around 2.5 million Dutch citizens experience difficulties regarding the digitalization of the Dutch society (Ministry of the Interior and Kingdom Relations, 2018). However, the size of the group that will be unable to use MaaS might be limited to a smaller group with the right adjustments. Further research needs to focus on the different designs of MaaS and quantify the particular groups that will experience a certain degree of transport related social exclusion as a result of the introduction of the different designs of MaaS.

8.3.2 Evaluate the potential of the sharing economy to ensure lower incomes access to a car

The introduction of MaaS is suggested to decrease the privately owned car, because the Dutch population will use more shared transport modalities according to the literature review (Zijlstra & Durand, 2019). However, this effect is only examined for the early adopters of MaaS. Therefore, the effect of MaaS on the accessibility of a car for people with a high risk on transport related social exclusion needs to be examined in order to conclude whether MaaS will contribute to increased accessibility by offering shared cars. Even though shared cars are available for these groups, an individual's budget might still be a barrier to access the on-demand car (Meerbach interview, 21st April 2020).

8.3.3 Estimate potential for the inclusiveness of the rural areas

The research revealed that MaaS might contribute to improved accessibility of the rural areas, which implies a more inclusive Dutch transport system (CIVITAS, 2016). However, most of the operational MaaS platforms and pilots focus on the urban area. Actively steering of the development by the government is required in order to improve the offerings in the rural areas. Therefore, it is recommended to thoroughly analyze the MaaS pilots of Twente and Groningen-Drenthe in order to validate the suggested positive outcomes on the basis of quantitative data as a result of the active role in these MaaS pilots.

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Appendix A: Mobility as a Service

This appendix elaborates on the concept Mobility as a Service. Mobility as a Service is still in its infancy. Therefore, the definition is still under construction since Hietanen envisioned the MaaS definition in 2014: “MaaS is a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider” (Hietanen, 2014, p. 2). What is exactly understood by Mobility as a service at this moment is discussed in subsection A.1. In the definition of Mobility as a Service the level of integration of payment, ticketing and bundling is used. Therefore, an extensive elaboration on the different integration levels suggested by the different researchers is presented in subsection A.2.

The mobility concept, Mobility as a Service, has great potential to improve the accessibility and livability of both the cities and the rural areas according to the researchers of the Netherlands Institute for Transport Analysis (Harms et al., 2018). For that reason, the Ministry of Infrastructure and Water Management would like to have all the potential diminishing and deepening effects of MaaS on transport related social exclusion examined (Ministry of Infrastructure and Water Management, 2017). The Ministry of Infrastructure and Water Management desires to know the effect of the introduction of Mobility as a Service on social exclusion among other potential consequences of the introduction. In order to minimize the negative effects and maximize the positive effects a certain degree of cooperation is required. The actors needed for a successful introduction of Mobility as a Service are introduced in subsection A.3. Besides, the government's role within the introduction and development of MaaS is discussed in subsection A.3. At last, in subsection A.4 the information obtained from the literature will be combined in order to demarcate what the exact elements are of hypothetical mobility as a service platforms analyzed in this research.

A.1 Definition Mobility as a Service

MaaS Global claimed to be the first true MaaS operator and is operational since 2016 in Helsinki (Whimapp, 2015). Therefore, the amount of extensively analyzed MaaS platforms or pilots is still limited (Smith et al., 2018). Hietanen is considered the founder of the concept Mobility-as-a-Service (Zijlstra & Durand, 2019). Ever since Hietanen in 2014 envisioned the MaaS definition, debates are going on about the exact definition of Mobility as a Service. In table A.1 the proposed definitions by the different researchers and institutions are provided. The reasoning behind including a definition of a certain institution or researcher is explained in the second column of table A.1.

Table A.1: Definition of Mobility as a Service according to different institutions and researchers.

Institution and responsible researcher	Reasoning to consider definition	Definition
(MaaS Alliance, 2019)	The definition of MaaS Alliance is proposed as the starting point of this research to demarcate the concept of Mobility as a Service, because the Ministry of Infrastructure and Water Management is one of the members	“Mobility as a Service (MaaS) is the integration of various forms of transport services into a single mobility service accessible on demand”

	of this alliance among other powerful members (MaaS Alliance, n.d.).	
(MuConsult, 2017)	<p>The Ministry of Infrastructure and Water Management requested research agency MuConsult to research the relatively new mobility concept, mobility as a service, which resulted in the following definition of Mobility as a Service.</p> <p>The definition is used by the Ministry of Infrastructure and Water Management for their reports to describe Mobility as a Service (BRON Market consultation)</p>	<p>(Translated from Dutch to English)</p> <p>“MaaS is defined as the offer of flexible, partly demand-driven, multimodal mobility services where tailor-made integrated travel options are offered to travelers through a digital platform.”</p>
European Commission (Lennert et al., 2017)	<p>The Netherlands is one of the 27 members of the European Union. Therefore, the definition of Mobility as a Service used in the European context is of importance for the Dutch government due to the agreement of free transport of people and goods within the European Union.</p>	<p>“Mobility as a service (MaaS) enables multimodal mobility by providing user-centric information and travel services such as navigation, location, booking, payment and access that allow the users to consume mobility as a seamless service across all existing modes of transport.”</p>
MAASifie (König et al., 2016)	<p>MAASifie is a project financed by the CEDR, which is an organization consisting of the European National Road administrations. The Dutch National Road Administration is part of the CEDR. A representative of Rijkswaterstaat looks after the interests of the Dutch Government.</p>	<p>“Multimodal and sustainable mobility services addressing customers' transport needs by integrating planning and payment on a one-stop-shop principle”</p>
MaaS Lab (Kamargianni et al., 2018)	<p>MaaS lab is one of the leading research teams that focuses on Mobility as a Service. Even though MaaS Lab lacks a link with the Dutch government, this definition is considered, because several leading researchers with their focus on MaaS have cooperated on the definition of the MaaS Lab.</p>	<p>“Mobility-as-a-Service (Maas) is a user-centric, intelligent mobility management and distribution system, in which an integrator brings together offerings of multiple mobility service providers, and provides end-users access to them through a digital interface, allowing them to seamlessly plan and pay for mobility.”</p>

The focus of this research is on the Dutch society. Therefore, the institutions or collaborations researching Maas, who are linked to the Dutch government are considered in order to demarcate the concept Mobility as a Service. The definitions presented in table A.1 show a number of similarities. Nevertheless, a generally accepted definition of MaaS does not exist yet. Therefore the different definitions need to result in the demarcation of what is understood by Mobility as a Service in this research.

The researchers and institutions agree on the fact that MaaS is a user-centric multimodal mobility concept offered by an integrator. The integrator should offer the customer tailor-made mobility using all the existing transport services. Therefore, the integrator needs to bundle all the different transport services, both public and private (Kamargianni et al., 2018). Both the traditional and the modern on-demand transport companies need to be included in the offers of the MaaS provider, because the shared economy is suggested to result in the shift from ownership to on-demand services (Pangbourne et al., 2020). In the current situation the end-user needs separate accounts to travel with different modes of transport. As a result of the introduction of MaaS the end-user does the planning, booking and payment of a single journey or mobility package through the MaaS platform, which is clarified in figure A.1. It is suggested that MaaS will only be successful if all the mobility providers and transport operators are included and as such meet the end-users mobility needs (Lennert et al., 2017).

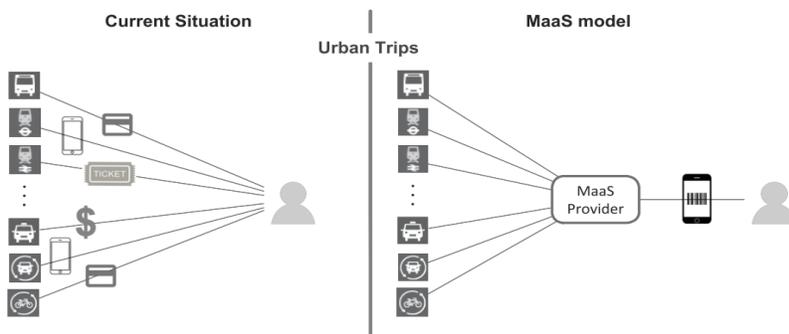


Figure A.1: Current situation without MaaS and the potential situation with MaaS ((Source: Kamargianni et al. (2018))

Besides the user-centric and multimodality aspect of MaaS, the digital platform is one of the aspects that is appointed by the European MuConsult and MaaS Lab (Kamargianni et al., 2018; MuConsult, 2017). Even though not all the definitions mention the digital platform, it is considered essential for Mobility as a Service. In order to offer the user information and transport services as booking, payment and navigation a device with internet is required to connect with the Mobility as a Service provider (Li & Voegelé, 2017). For that reason the digital platform is considered to be an essential aspect for effective MaaS.

In table A.2 the core characteristics of MaaS on the basis of the presented definitions of institutions related to the Dutch government are presented.

Table A.2: The proposed characteristics of Mobility as a Service

Considered MaaS characteristic for this Research	Explanation of the characteristic

Multimodal	All the definitions suggest a certain level of multimodality. The Mobility as a Service provider should provide the end-users mobility. All the existing transport services need to be offered by the provider in order to arrange the most efficient end-to-end trip using all the available transport modalities. The user should only pay once for the whole end-to-end trip even though the end-user is making use of multiple transport modalities.
One digital platform	Mobility as a service uses a digital platform to offer the real-time information and transport services as booking, payment and navigation. In order to make use of Mobility as a Service a phone or any other device able to connect with the Mobility as a Service provider is needed (Li & Voegelé, 2017). One single mobility provider should provide all the existing transport services in the digital platform in order to meet the needs of the end-users.
User-centric	The Mobility as a Service provider focuses on the uniqueness of the end-user and offers tailor-made integrated travel options to meet the mobility needs of the end-users more effectively. The digital platform should recommend the end-user tailor-made mobility offers on the basis of the end-user's preferences (Hietanen, 2014).
Booking & Payment	MaaS should offer seamlessly booking and payment for the end-users. Ghanbari et al. (2015) suggested that Mobility as a Service should take away the necessity to have separate accounts to pay for the different modes of transport. Besides, the MaaS provider should offer a "mobility package" and a "pay per trip" (Whimapp, 2015). The mobility package could be a monthly payment that enables the use of the different transport modes, while the "pay per trip" should only be the payment for the effective traveled distance
Planning	Travel planning is of great importance for Mobility as a Service in order to show the end-user the different options and meet the transport needs of the unique end users (Zijlstra & Durand, 2019).
Information, navigation	Real-time information and navigation needs to be provided to the customers to satisfy the more demanding customers. As a result of real-time information and navigation the transport system can become more responsive, more efficient and more robust (MuConsult, 2017).

These six characteristics derived from the literature are together considered to define and demarcate Mobility as a Service. In subsection A.4 the characteristics are used to show what is understood by MaaS schematically. The integration of these six characteristics differ among the different integration levels of MaaS suggested by researchers. In the next subsection the different integration levels are discussed and the corresponding integration level with the proposed definition is determined.

A.2 Different Integration Levels

According to Kamargianni et al. (2016) the MaaS concept of the integration of three elements; ticket & payment integration, mobility package and ICT integration. The more elements being part of the particular

MaaS platform, the higher the level of integration. Next to Kamargianni et al. (2016), other researchers have focused on the integration levels of Mobility as a Service as well (Lyons et al., 2019; Sochor et al., 2015).

Sochor et al. (2018) suggested that there are four levels of integration for MaaS. Besides, Sochor et al. (2018) indicated a level zero, which represents the current situation of the Dutch transport system, where all the means of transport are offered by separate services. A higher level of integration is related to the inclusion of the three elements proposed by Kamargianni et al. (2016). In level one of Sochor et al. (2018) only information of the costs, routes and timetables of the different available travel modalities is combined within one single interface in order to plan a journey. 9292 and google are excellent examples of a level 1 integration according to the typology of MaaS of Sochor et al. (2018). These platforms offer the customer of mobility information about the different options to execute a trip using different modalities. In addition to level one, level two includes the payment and booking for their whole trip within one single platform.

Lyons et al. (2019) proposed five levels and the level zero of no integration for Mobility as a Service. The focus of Lyons et al. (2019) was on the cognitive user effort, which corresponds with the user-centric characteristic of MaaS suggested in subsection A.2. The highest level of integration of Lyons et al. (2019), level five, has full integration under all conditions. Full integration implies seamless door-to-door transport, which can be planned, booked and paid through one single platform. The highest level corresponds with the level which can be compared with the integration level two of Sochor et al. (2018), because both of the levels of integration include all three of the integration elements of Kamargianni et al. (2016). However, both Kamargianni et al. (2016) and Sochor et al. (2018) make a distinction between the integration of “mobility packages” and solely “pay per trip”.

Therefore, Sochor et al. (2018) proposed two additional levels of integration. The third level of integration of Sochor et al. (2018) corresponds to the highest of Kamargianni et al., level four.

This integration level includes bundles and passes to provide the end-users an alternative to meet their mobility needs, the so-called mobility packages. Whimapp and Ubigo are the only two apps of level three in respectively Gothenburg and Helsinki, which means that these two MaaS operators try to create value for both the suppliers, transport services, and the end-users by increasing the total purchase of the different transport services (Smith et al., 2018). Through offering other modalities by the service provider to cover all the mobility needs of an individual, MaaS becomes an alternative for the ownership of a car or a bike (Kamargianni et al., 2016). The highest level of Sochor et al. (2018) also integrates societal goals in order to achieve desirable societal outcomes as a result of the introduction of MaaS. Applying policies to change the behavior by using MaaS has not been done yet, but is considered a powerful steering instrument to improve the sustainability and livability of the Netherlands (Harms et al., 2018).

The Netherlands Institute for Transport Policy Analysis suggested that the integration of information, booking and payment is the minimum level of integration needed to consider a particular platform as MaaS (Harms et al., 2018). However, in subsection A.1 the bundling of transport services into contracts is considered an important characteristic of MaaS, which would imply this research will focus on a MaaS platform with an integration level three instead of the minimum integration level two suggested by the Netherlands Institute for Transport Policy Analysis. However, the goal of this research is to provide the Dutch government an exploratory opinion, advice, on the possible steering options to obtain the desirable outcomes. The introduction of Mobility as a Service should maintain or even improve the inclusivity of the current transport system. Therefore, a certain integration of sustainable goals needs to be considered like

Sochor et al. (2018) proposed in order to achieve the desirable societal outcome, an inclusive transport system. The need for an inclusive transport system emphasizes to opt for a MaaS platform of integration level four according the proposed topology of MaaS of Sochor et al. (2018), which implicates that the Dutch government will actively steer the development and execution of MaaS to obtain an inclusive transport system.

A.3 Involved Actors and The Government's role

In order to create a successful MaaS, cooperation between both public and private transport companies is required (Sochor et al., 2015). Next to cooperation between these different transport companies, cooperation between these companies and the government as a legislator and provider of subsidies is essential (Pangbourne et al., 2020; Karlsson et al., 2019). These companies need to collaborate in order to create a new type of collective transport (Sochor et al., 2015). There is resistance and inertia to overcome amongst supply-side actors before an effective execution can be expected (Lyons et al., 2019). In this subsection the field of actors within the MaaS Business Ecosystem is clarified while focusing on the different potential roles for the Dutch government within the development and execution of a successful MaaS platform.

One of the important supply-side stakeholders and thus involved actor, is obviously the MaaS provider, the organization that combines the different transport services (Jittrapirom et al., 2017). The transport services are provided by both public and private transport operators. The end-users at their turn purchase the different transport services through the offered packages or bundles offered by the MaaS provider. However, a data provider, responsible for the handling of the bookings, payment and telecommunication among other things, is indispensable for a properly working MaaS application (Kamargianni et al., 2018). The data provider ensures the payment of the traveler is divided according the payment contracts between the MaaS provider and the transport services.

It is of great importance to indicate the possible candidates that can be the MaaS provider. MaaS could be developed through the initiative of the public sector in order to achieve the desirable societal outcomes. MaaS can in that option develop in three scenarios, which are based on the degree of engagement of the public sector. Respectively market-driven, public-controlled and public-private (Smith et al., 2018). The MaaS development needs steering of the national or regional government in order to achieve the desirable societal outcome (Pangbourne et al., 2018). According to Kamargianni and Matyas (2017) either a public transport authority or a private company should be the Mobility as a Service provider. The big advantage of a public transport authority as a MaaS provider is that it is easier to secure all the public transport within the MaaS platform. On the other hand, if a private company develops MaaS, the private company will put more effort in the economic success of MaaS due to the commercial nature of the private company (Kamargianni & Matyas, 2017).

The MaaS Business Ecosystem consists of a broad range of actors besides these four actors. The four actors discussed in the previous subsection are considered the core business of the MaaS Business Ecosystem (Kamargianni & Matyas, 2017) (Figure A.2: Core business). Even though, the MaaS provider could create the technology for their platform themselves, Kamargianni and Matyas (2017) suggested that the technology specific actors offering the technology to the MaaS provider are of great importance, because developing the technology will be probably outsourced by the MaaS provider, because of the necessity of technology expertise to construct and maintain the MaaS platform. Besides the technology specific actors, the introduction of MaaS is an opportunity for insurance companies and investors to financially benefit

from this new market. As a result of the fact that MaaS is a relatively new mobility concept, the research institutes and universities are of importance for the other actors to provide knowledge over the different aspects of this concept. This research shows the importance of research examining the different impacts of MaaS in order to inform the Dutch government in how to steer the development of MaaS (Ministry of Infrastructure and Water Management, 2017).

An important role for the Dutch government as regulators and policy makers can be derived from the proposed MaaS Business Ecosystem (Figure A.2: Business Ecosystem). For a successful implementation of MaaS open data and standardized APIs (application program interface) are required (Karjalaibnen, 2017). The government has made the first step in standardized APIs and open data in 2019 by creating eight MaaS specification requirements for concessionaires that will be put into operation in 2022 (CROW, 2019).

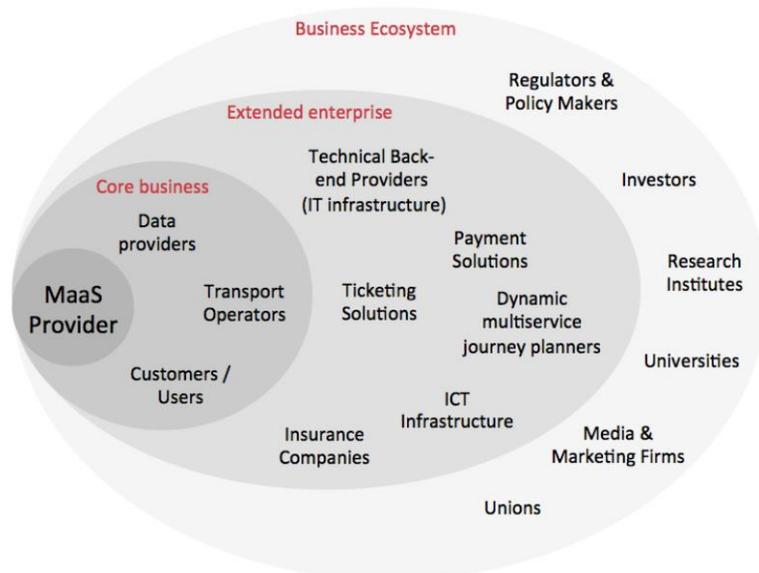


Figure A.2: The MaaS Business Ecosystem (Source: Kamargianni and Matyas (2017))

As a result of the complex field of actors and potential major consequences of the introduction of MaaS, it can be argued that the MaaS development needs steering of the national or regional government in order to achieve the desirable societal outcome (Pangbourne et al., 2018). Even though the development of MaaS through a private company could result in advanced and personalized offers for the end-users, it is of great importance that the government either takes an active role by supporting a public transport authority as MaaS provider or actively steers the development of MaaS as legislator (Kamargianni et al., 2018). Otherwise MaaS will not meet its own high expectations related to financial and ecological sustainability (Karjalaibnen, 2017).

A.4 Considered Mobility as a Service in this Research

The demarcation of the concept Mobility as a Service results in a proposed schematic overview of what is understood by Mobility as a Service in this research (Figure: A.3). The core business of the MaaS Business Ecosystems, MaaS provider, end-users, transport services and data provider, are displayed in the schematic overview together with the Dutch government (subsection A.3). The Dutch government is included in in this schematic overview to show the steering options of the government on the development

and execution of MaaS. The arrows between the different actors indicate the most important relations and how they interact between the main actors.

Next to the main actors, the core characteristics of MaaS derived from literature in subsection A.1 are appended to the schematic overview of the proposed Mobility as a Service demarcation. A number of the core characteristics of MaaS derived in subsection A.1 are represented in the MaaS platform, multimodal, booking & payment, planning and information & navigation. One of the characteristics is considered a fundamental aspect of the end-users, namely the fact that the MaaS platform is a digital platform. This characteristic is a characteristic of the end-user, because it is essential that an end-user owns a device to be able to connect with the MaaS platform, without a device booking and planning a journey at the MaaS platform is impossible (Li & Voegelé, 2017). The user-centric characteristic of Mobility as a Service is not explicitly stated down, but is indicated with the personalized offers as an element of the MaaS platform designed by the MaaS provider.

The three main elements of MaaS, ticket & payment integration, mobility package and ICT integration, proposed by Kamargianni et al. (2016) are all integrated in the proposed concept of Mobility as a Service. These elements can be found as the characteristics of the MaaS platform. Besides, the arrows from the Dutch government represent regulations and policies on the development and execution of the concept of MaaS leading to desirable outcomes, for example reduced car ownership and improved livability (Utriainen & Pöllänen, 2018). Therefore, it can be concluded that the proposed demarcation is in line with the topology of Sochor et al. (2018) of integration level four (subsection A.2).

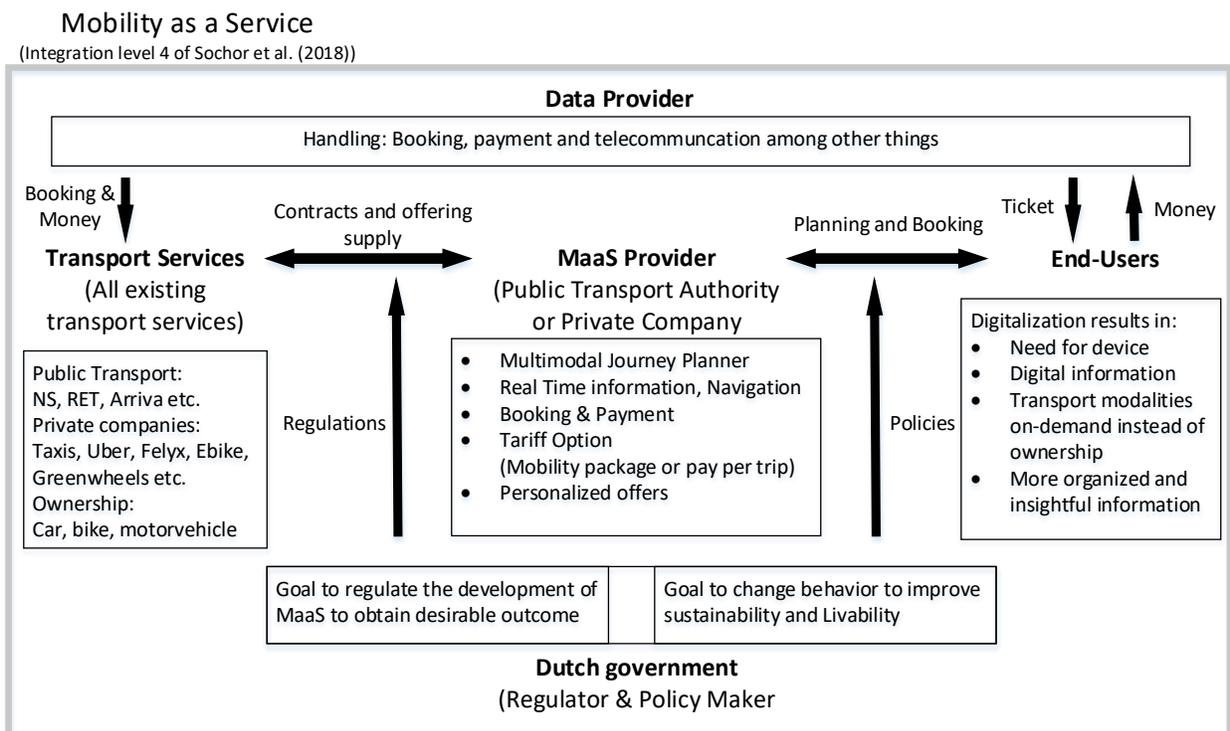


Figure A.3: Demarcation of the key concept, Mobility as a Service

Appendix B: Interviewees and Interview Questions

Experts with specific knowledge about Mobility as a Service and/or transport related social exclusion are interviewed (Table B.1). For both of the concepts and the relations between the concepts a list with possible interview questions is formulated and presented on the next page. For every interview questions are selected for the interview based on his or her knowledge of the particular concept.

Table B.1: Interviewees presented with their expertise and date of interview

Interviewee	Date	Expertise
Astrid Kampert	20 th of April, 2020	Astrid Kampert is statistical researcher for the Dutch Central Bureau of Statistics. She focuses on researching the developments of Dutch mobility patterns and needs. Recently she developed an indicator that measures the risk of an individual on transport related social exclusion. She did two studies focusing on this particular indicator.
Rolf Meerbach	21 st of April, 2020	Rolf Meerbach works as a policy officer for the Province of Drenthe. He is the project manager of the MaaS pilot Groningen-Drenthe. The goal of this MaaS pilot is to improve the inclusiveness of the Dutch transport system by providing adequate information to people about the available mobility options.
Jaap Sytsma	22 nd of April, 2020	Jaap Sytsma works for MuConsult BV as an advisor on Mobility as a Service and public transport. He contributed to “the white paper Mobility as a Service” for the Ministry of Infrastructure and Water Management among other things. The definition developed in this research is used by the Ministry to describe MaaS in other reports.
Rob van der Bijl	22 nd of April, 2020	Rob van der Bijl is visiting Professor Mobility Planning at Ghent university. Besides, he performed a research focusing on transport related social exclusion. The main conclusion was that in some deprived neighbourhoods in the Netherlands 20 percent of the population is experiencing a certain degree of transport related social exclusion.
Anne Durand	23 rd of April, 2020	Anne Durand works for the Netherlands Institute for Transport Policy Analysis. Besides, she is doing her PhD at the TU Delft. Her current researches are focusing on both transport related social exclusion and Mobility as a Service. In 2018 she finished a research about the changes in travel preferences and travel behavior as a result of MaaS.
Interviewee with a higher risk on transport related social exclusion	24 th of April, 2020	The interviewee has a higher risk on transport related social exclusion, score 1, according to the indicator of CBS and PBL prompted by her age and geographical location among other things. Nevertheless, she fully participate in the society and is digitally skilled. She has peers with difficulties about who she can tell.
Stephanie Akkoui Hughes	24 th of April, 2020	Stephanie Hughes is an employee of “De Verkeersonderneming” researching mobility happiness. She spoke at the MaaS congress about the need for an inclusive MaaS app, because she had concluded that even in the Netherlands people are not able to participate in the society as a result of lack of transport.

Interview Questions

MaaS in General

- How would you describe MaaS?
- What are the core characteristics of MaaS according to your expertise?
 - Is the government necessary to steer the development of MaaS to obtain desirable societal outcomes?
- Will MaaS change the existing ownership-based transport system into an access-based one?
 - Will the introduction of MaaS speed up this phenomenon?
 - Will the introduction of MaaS decrease the amount of privately owned cars?
- Will MaaS increase the use of sustainable transport modalities?
 - Will MaaS result in a shift away from public transport, because other travel options become easily available?

Transport related social exclusion

- What is your definition of transport related social exclusion?
- Are people in the Netherlands transport related socially excluded?
- What are the vulnerable groups experiencing a high risk on transport related social exclusion?
- What are the dimensions of transport related social exclusion according to your knowledge?
- What are potential exclusionary factors that pose a barrier resulting in reduced accessibility?
 - Temporal barriers
 - Financial barriers
 - Physical barriers
 - Psychological barriers
 - Informational barriers
 - Spatial barriers
 - Organizational barriers
- What are examples of an individual's circumstances that pose a barrier to his or her accessibility?
- What are examples of Dutch transport characteristics that pose a barrier to an individual's accessibility?
- What is the relationship between personal circumstances and the existing transport characteristics?
- Does the population with specific personal circumstances influence the required transport characteristics
 - Which transport characteristics and personal circumstances?
- Does the transport characteristics ensure participating of individuals with certain personal circumstances?
 - Which transport characteristics and personal circumstances?

MaaS in relation to transport related social exclusion

- Which groups benefit from MaaS at the early stage?
 - If MaaS was the only transport option, will everybody be able to participate in society?
- Will MaaS be a complement to public transport in rural areas?
- Will MaaS ensure faster transport for every Dutch citizen?
- Will MaaS remove the need for car ownership to travel?

- Will MaaS change the existing Dutch transport infrastructure?
- Will MaaS influence an individual's perception of the Dutch transport system?
- Will MaaS change the provision of information?
 - Will the information provision improve?
 - Will the information provision become more accessible?
 - For which population groups?
- Will MaaS diminish or remove financial barriers?
 - Can MaaS contribute to a higher efficiency of the available infrastructure?
- Will the personalized travel options result in diminishing effects of certain posed barriers?
- Will the dependency on data result in barriers for the Dutch population?
- Will MaaS remove or diminish certain barriers for transport related socially excluded people?

Conditions in order to benefit from MaaS regarding the inclusiveness of the transport system

- Should the Dutch government steer the development of MaaS?
- What should be the role of the Dutch government?
 - Data provider or MaaS provider or Legislator or No interference
- Will the introduction of MaaS become successful in terms of inclusiveness without policies?
 - Will the well-known governance such as pricing structures, consumer protection and coverage be successful or are out of the box policies required?
- Which policies do you suggest in order to ensure the introduction of MaaS will improve the inclusiveness of the Dutch transport system?

Appendix C: Checklist Interviews

In Table C.1 the consolidated criteria for reporting qualitative studies of Tong et al. (2007) are used to explicitly formulate important aspects of the performed in-depth semi structured interviews.

Table C.1: Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist (Tong et al., 2007)

No	Item	Guide questions/description	Answers
Domain 1: Research team and reflexivity			
Personal Characteristics			
1.	Interviewer /facilitator	Which author/s conducted the interview or focus group?	Jesper Kloeke
2.	Credentials	What were the researcher's credentials? <i>E.g. PhD, MD</i>	Master student
3.	Occupation	What was their occupation at the time of the study?	Master Engineering and Policy Analysis
4.	Gender	Was the researcher male or female?	Male
5.	Experience and training	What experience or training did the researcher have?	A bachelor "Technische Bestuurskunde" and successfully attended a course to develop interview skills.
Relationship with participants			
6.	Relationship established	Was a relationship established prior to study commencement?	With none of the respondents
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? <i>e.g. personal goals, reasons for doing the research</i>	The aim of the research is to define the effects of MaaS on transport related social exclusion.
8.	Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? <i>e.g. Bias, assumptions, reasons and interests in the research topic</i>	Interviewer completed an extensive literature study about the relationship of MaaS and transport related social exclusion
Domain 2: study design			
Theoretical framework			
9.	Methodological orientation and Theory	What methodological orientation was stated to underpin the study? <i>e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis</i>	The proposed conceptual framework in chapter was used to guide the interviews, which is based on multiple different researches. The framework of Lucas (2012) was important input for this framework.
Participant selection			
10.	Sampling	How were participants selected? <i>e.g. purposive, convenience, consecutive, snowball</i>	Purposive
11.	Method of approach	How were participants approached? <i>e.g. face-to-face, telephone, mail, email</i>	By email.

12.	Sample size	How many participants were in the study?	7
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	0
Setting			
14.	Setting of data collection	Where was the data collected? e.g. <i>home, clinic, workplace</i>	By phone or skype due to the coronavirus
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	Only interviewees and the researcher.
16.	Description of sample	What are the important characteristics of the sample? e.g. <i>demographic data, date</i>	The interviewees need to have specific knowledge about at least one of two key concepts.
Data collection			
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Only if the interviewee asked the questions up front the questions were provided.
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	Audio recording
20.	Field notes	Were field notes made during and/or after the interview or focus group?	No
21.	Duration	What was the duration of the interviews or focus group?	Approximately 30 minutes
22.	Data saturation	Was data saturation discussed?	Yes
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	Yes
Domain 3: analysis and findings			
Data analysis			
24.	Number of data coders	How many data coders coded the data?	1
25.	Description of the coding tree	Did authors provide a description of the coding tree?	No
26.	Derivation of themes	Were themes identified in advance or derived from the data?	Derived from the data
27.	Software	What software, if applicable, was used to manage the data?	RQDA
28.	Participant checking	Did participants provide feedback on the findings?	No
Reporting			
29.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes
30.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? e.g. <i>participant number</i>	Yes

31.	Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
32.	Clarity of major themes	Were major themes clearly presented in the findings?	Yes

Appendix D: Themes and Related Codes for every Interviewee

In table D.1 the themes and its related codes are presented. The content analysis was performed using the software RQDA. Table D.1 provides information about both the amount of times an interviewee mentioned one of the codes and the amount of times an interviewee spoke about a certain theme.

Table D.1: Themes and related codes mentioned by interviewee

Theme	Code	Anne Durand	Anonymous Interviewee	Astrid Kampert	Jaap Sytsma	Rob van der Bijl	Rolf Meerbach	Stephanie Akkaoui Hughes	Total times mentioned code
Conditions of an Inclusive MaaS	Adjustments to the digital platform have to be made to include more people						1		1
	All parties, end-users, service providers and the government need to be aligned in order to achieve societal desirable outcomes					1		1	2
	Calling service		1				1		2
	Commercial services need to contribute to governmental goals with the help of the Government		2		1				3
	Data can improve policies in order to ensure inclusiveness						1	1	2
	Data obtained through MaaS can be useful to improve Dutch mobility policy				1		2		3
	Data should be used by the Government to learn from travel behavior							2	2
	Individual mobility budgets to remove financial barriers to travel				1	1			2
	Package message differently for all the different segmentations of Dutch society							2	2
	Services should be offered more simply	1	1				1		3
	Some groups of the population are not interested in courses about digitalization		1						1
	Subsidies of Dutch government to improve inclusivity				1				1
	The societal goals need to be aligned with goals of the target group to persuade them to use MaaS	1	1				3		4

	Traditional transport system should remain available		2		1			3	
Total times mentioned theme Conditions of an Inclusive MaaS		2	8		5	5	6	10	36
Goals and Ambitions of MaaS	Choices for travelers will increase				1			1	2
	Convenience and flexibility for personal optimal journey				1		3	1	5
	Data sharing is not feasible					2			2
	Intention to remove car ownership	1					1	1	3
	MaaS is in its infancy				1	1	2		4
	MaaS provides a lot of data about travel behavior						1	1	2
	MaaS will stimulate the sharing economy						1		1
	Not about ownership, but about access	1					1	1	3
	Offering all the existing transport offers						1		1
	Planning, Booking and Payment in one digital app				1		1		2
	Private car remains fastest travel option	2					1		3
	Seamless travel						1		1
	Second car can be replaced with a shared car				1				1
Sustainability is not top priority of general public by choosing transport modalities							1	1	
Total times mentioned theme: Goals and Ambitions of MaaS		4			5	3	13	6	31
Insurmountable barriers resulting in reduced accessibility regardless introduction of MaaS	A lot of different barriers pose a barrier to an individual's accessibility	1					1		2
	Bike as available transport modality is really important			2	1		1		4
	Even in the Netherlands people are transport related socially excluded					1	1	1	3
	Even ownership of bike poses financial barriers				1				1
	Facilities are increasingly concentrated in the urban areas						1		1
	Never everybody will be included	2		1				1	4
	New criteria for travelers is healthy journey							1	1
	Only transport related socially excluded if people are unable to participate according to themselves due to lack of mobility			2					2
	People with limited mobility budgets like to have control even if it results in higher costs eventually							1	1

Total times mentioned theme: barriers resulting in reduced accessibility regardless introduction of MaaS		3		5	2	1	4	4	19
MaaS result in reduced accessibility	Certain groups lack ability to access digital app	2	2		1	2	2	2	11
	Implemented mobility options similar to MaaS scored poorly on financial aspects					2			2
	Implemented mobility options like MaaS scores poorly on understandability					1			1
	Lack of trust in data dependent digital app	3	2					1	6
	MaaS will not remove and even enlarge financial barriers				1	1	1	1	4
	Without governance extra people will be excluded				2	1			3
Total times mentioned theme: MaaS result in reduced accessibility		5	4		4	7	3	4	27
MaaS results in increased accessibility	Access to car will improve accessibility for people that can afford shared car				2				2
	Accessibility depends on the frequency, transfer option among other things that can be optimized with MaaS			1					1
	Information provision more organized and insightful	2		1	2		2		7
	Mobile population profits from MaaS		1			2		2	5
	Most people accept that data is obtained	1	2						3
	People executing multimodal journeys already will benefit from MaaS	1	1						2
People more aware of transport offer resulting in perceived increased accessibility			1	2		2		5	
Total times mentioned theme: MaaS results in increased accessibility		4	4	3	6	2	4	2	25
Role of the government	Creation of a level playing field				1	2			3
	Ensure a certain level of accessibility for everyone	1			1	1	1		4
	Ensure livability				1	1	1		3
	Governance is essential in order to improve the accessibility of rural areas	2			1	1	1		5
	Government should prevent that the gap between people with high accessibility and people with low accessibility enlarges	1			1	2		2	6
	Governance required to obtain desirable societal outcomes	1		1	3	1	1	2	9

Government need to steer commercial companies to prevent them from only caring about profit	1	1		3	2	2	3	12
Limited budget means that government has to make choices	1		1		1			3
Maybe MaaS is not solution to deal with these issues. However, these issues need to be taken into account				1			1	2
Mobility is a cornerstone of the Dutch society and need to be seen as a public good	1			1	3			5
Parking standards can reduce first car ownership				1				1
Regulate and legislate the development of MaaS		1		1		1	1	4
The debate on social and moral issues is at least as important as the technical side of MaaS					3			3
Total times mentioned theme: Role of the government	8	2	2	15	17	7	9	60
Total identified codes per interviewee	26	18	10	37	35	37	35	198