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Scenarios for future development of smart mobility:

A case study of the opportunities for MaaS in the city of Groningen

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Abstract

Currently a shift is taking place in the mobility domain towards 'smart' mobility services. With the aid of ICT the mobility domain is developing towards new forms of mobility. These developments bear the promise of more efficient and sustainable transport modes. One of these smart mobility developments is Mobility-as-a-Service, or shortly MaaS. The principle of MaaS is that it focuses on the integration of various transport modes offered to the customer through one platform and based on their wishes. This research focuses on this new development and the opportunities that it may pose for the transport system in the future. However, since MaaS is new and transport system developments are highly complex, the effect that these developments may are subject to substantial uncertainty. To deal with these uncertainties the scenario approach has been used in this research to gain more insight in possible futures that MaaS may generate. Furthermore, governance plays an important factor as a tool for strategic decision making about the future to be able to decrease the amount uncertainty. In this research scenarios have been developed to explore possibilities for MaaS in the Dutch city of Groningen. The chosen time frame for the scenarios covers the coming 10 years. Following from the scenarios the main research question that has been formulated is:

What are possible scenarios that Mobility-as-a-Service can generate in Groningen for 2030, and what policy recommendations can be made about them?

Findings in this research followed from interviews with experts of MaaS-related development. The interview data has been used to draw up four scenarios that spur the discussion about what possibilities and threats can be envisioned for MaaS development in the coming 10 years. Furthermore these results and the scenarios have led to some recommendations for governance and policymaking.

This research concludes that the willingness to change travel behavior and acceptance of MaaS-related travel options appear to be significant. Apart from the costs, the efficiency and other practical factors, it is the behavioral factors that will determine the success of MaaS development. Furthermore, with regards to governance, there is a need for cooperation between public and private parties to ensure the best from both sides, that is to say societally desired as well as economically profitable development. Lastly, this research pleads for an adaptive policymaking approach, due to the complex and uncertain nature of MaaS development in this fast-paced and quickly changing world.

Keywords Smart Mobility, Mobility-as-a-Service, MaaS, Governance, Uncertainty, Scenarios

Acknowledgements

The Master thesis lying in front of you marks the end of my, as it seems, quite diverse academic education. Starting in Utrecht with a very broad Bachelor in Liberal Arts and Sciences, where I learnt how to practice an interdisciplinary approach. Combining my many academic interests in my studies with a major in Human Geography, a specific focus on international development studies and even a minor in administrative- and organizational sciences. Moving on to a Masters in geography and communication which provided me with an internship at Rijkswaterstaat. Here, my interests for geography and planning, but also sustainability were enhanced and this led to starting my next and final academic education in Groningen in Environmental and Infrastructure planning. The focus on a combination of spatial planning, policymaking and sustainability appeared to be exactly the right fit for me. The thesis laying in front of you has been the final assignment for completing this degree.

This Master thesis has been written from my interest in smart city development and therefore also smart mobility. I, and many others with me, feel like we are at the dawn of a new era with regards to the mobility system. Mobility-as-a-Service (MaaS) is one of the new developments that have the potential of disrupting, and evolving the mobility system in something completely new.

It has been a pleasure as well as a struggle researching this topic, because of the newness and the extreme amount of uncertainty surrounding it. Nevertheless, it has been great interviewing respondents engaged in MaaS development with a lot of enthusiasm. I want to thank all of them greatly for their contribution to this research, because I could not have don't it without them.

I also want to thank my supervisor, Robin Neef for his time and unconditional support. His feedback was extremely helpful and encouraged me to carry on time and time again. Furthermore, my family has always been a major support during my education and I thank them for having faith in me and my abilities. Last but not least I want to thank my friends and fellow students for their support, the many lunch breaks and library coffee dates, because they made writing this thesis bearable and eventually a successful operation.

Finally there is only one thing left to say;

Enjoy reading my thesis!

Melanie Cramer

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ICT	Information and communications technology
KIM	Kennisinstituut voor Mobiliteitsbeleid (Knowledge Institute for Mobility Policy)
MaaS	Mobility as a Service
MIC	Mobility Innovation Centre (renamed hive.mobility)
PBL	Planbureau voor de Leefomgeving (Netherlands Environmental Assessment Agency)
PPC	Public Private Cooperation

1 Introduction: Smart mobility on the rise

1.1 Relevance and problem description

"It is clear that a new era in the domain of mobility has begun." (Melanie Schultz van Haegen minister of Infrastructure and Environment, 2017, p. 7).

There is an active scientific debate about smart mobility developments and that they will revolutionize collective and personal mobility (Flugge, 2017; Marsden & Reardon, 2018; Dochterty et al., 2018). From the quote above it appears that these changes of the mobility system are also perceived in the Netherlands. The contemporary mobility system is changing under the influence of technological innovation, and also by the push of a growing demand for mobility services (Marsden & Reardon, 2018). When discussing the mobility system, this originally entailed seeing it as the whole of users and providers of transportation services (Flugge, 2017). But now, the addition of technological services through the internet seems to add another dimension to this definition. The addition of this new dimension also poses opportunities for making the mobility system more efficient and sustainable.

When discussing the developments in the mobility domain, the environment is an important factor that also has to be taken into consideration. For example, the increasing use of mobility services nowadays causes a lot of CO_2 emissions contributing to global warming. Furthermore, increased traffic will cause noise pollution, which is also proven to have a negative impact on both humans and animals (Sing & Davar, 2004). The pressure on the mobility system is only expected to increase, since the predictions are that by 2050, 70% of the world population will be living in cities (Dameri, 2014). This will put more pressure on the mobility systems in cities, causing traffic jams and more noise and air pollution (Stead, 2016). The current issues in the mobility domain will affect various aspects of the daily lives of all citizens, from the users of these services to the providers, to the policymakers steering and enabling these services.

Arising smart mobility developments have a reputation of being a possible answer to the mobility problems for citizens as well as for the environment. This is important now because of the increasing congestion and its effect on the environment. Smart mobility development entails using innovation and ICT to for example electrify vehicles (making them cleaner) or creating a platforms for sharing car rides with one another instead of personally owning them taking the pressure off the mobility system and using up less parking space (Benevolo et al., 2016). However, in practice smart mobility developments are still in their infancy, making it difficult to predict the actual effect they may have in the future when they may be adopted on a larger scale. One of the reasons for this is that the developments are steered by technological solutions. But, the success of these solutions depend also for a great amount on people becoming accustomed to them and changing their mindsets, which is more difficult to achieve (Flugge, 2017). For example, there is the question if people will ever really give up private vehicle ownership (Sprei, 2018). Besides, there are also critics that point out the negative effects smart mobility developments may have and that they can possibly undermine sustainable transport aims instead of enhancing them (Kitchin, 2015).

Kitchin (2015) is critical to smart city - and therefore also smart mobility - developments and observes that their possible negative consequences hardly being addressed in the literature, regarding for example the hollowing out of state provided services, cyber security issues and technological lock-ins that the developments may cause. There are also more ethical issues about how to set rules and who has which

rights, that can pose problems if not addressed. A concrete example can be the case of Uber where there are protests by incumbent operators against the service, while still there are many people that use the service of Uber (Marsden & Reardon, 2018). For authorities this poses a challenge about how this development can and should be regulated to avoid problems. Because of the uncertainty of the effect that some of the smart mobility developments may have, governance to deal with both the opportunities and problems is necessary. The previously mentioned examples point to a need for a way to also deal with these negative consequences and ensuring that the intended positive outcomes of the developments are realized.

Furthermore, these developments are changing the set and roles of actors that have been present in the mobility domain until now (Marsden & Reardon, 2018). For example the developments are already known to challenge the existing state-provider relationship, causing them to be resisted, redefined or renegotiated (Dudley et al., 2017). The smart mobility developments in themselves, and separately would already have an impact on the mobility system, but if multiple ones will be introduced this is going to make the changes even more complex. What is seen for example in smart mobility development is a shift to single mobility users becoming mobility providers in themselves with the help of ridesharing applications (Jittrapirom et al., 2017). If a substantial amount of citizens participate in this development it will have the ability to change the mobility dynamic to a significant extent (just like the impact of the introduction Uber mentioned in the previous section). Another development is the implementation of autonomous vehicles. These demand a new set of rules and regulations to function within the current system. If one or even more of these developments were to be implemented on a larger scale into the current mobility system, the effects would be profound. That is why smart mobility innovation is also often referred to as 'disruptive' (Marsden & Reardon 2018; Sprei, 2018). This indicates that there is a need for regulating these developments, which has been and still is usually done by governing bodies. The question remains how governing bodies can then enable or steer these developments so that they will contribute to a mobility system that benefits everyone and the disruption does not cause to many problems. Meaning for example that the system is safe, everyone has the ability to benefit equally and the impact on the environment is kept low.

1.2 Scope

A recent development that falls under the denominator of smart mobility and has gotten substantial attention is Mobility-as-a-Service (MaaS). The reason for this is because it consists not only than technical mobility development, but it also differs in the way that mobility services are made use of. As many of the smart mobility developments, it is also based on the use of ICT as main component (Nemtanu et al., 2016). Nowadays the mobility system is primarily focused on vehicles, infrastructure and transport modes (Ibid.). In MaaS however, there is a shift in this perception that goes more towards offering mobility in an integrated manner, meaning users are able to make use of various travel modes that can be accessed through one platform (Jittrapirom et al., 2017; Pangbourne et al., 2018; Smith et al., 2018). In this service customers can also share their means to travel with one another due to technology. In this development there is essentially less need to privately own vehicles like cars or bikes because they can be made use of through the pool of vehicles offered by MaaS providers or private owners eventually leading to more options to choose from. In MaaS customers use the internet, an app or a platform that calculates the best journey based on their preferences, and consisting out of different transport modes that the customer can choose from (Atkins, 2015). This opens up opportunities for customers to choose the most sustainable, the most cheap, or the most comfortable option. The development can in a positive sense contribute to less privately owned cars, and more efficient travel options, making the mobility system also more efficient. Furthermore, MaaS can also be beneficial in areas where public transport has low accessibility rates

(Gemeente Groningen, 2019). However, there are also pitfalls that can become reality when the developments do not have the right regulation and governance. Examples are exclusion of MaaS due to being unable to operate ICT related services, and the vulnerability that the reliance on ICT creates in general (Pangborne et al.) These benefits and pitfalls of MaaS can be known to a certain extent, but since MaaS is a new development much of its future is still unknown.

One method to do research about future, and therefore unknown, development is the scenario approach (Börjeson et al., 2006; Pérez-Soba & MaaS, 2015; Kuusi et al., 2015). Scenarios of what the future of MaaS may look like can contribute to envision what can be done to contribute to the development for it to grow and contribute to sustainability and a more effective mobility system. This will be necessary to get a grip on how planners and governing bodies can help with the strengthening of urban areas responsiveness to changes, while at the same time ensuring that the developments go in a direction that is mostly desired by society (Rauws, 2017). The level of uncertainty in planning for the changes that developments such as MaaS may bring about is high, since the mobility system in itself is elaborate and complex. Lyons & Davidson (2016) classify changes in the mobility paradigm as being extremely high, meaning that they cannot be addressed by gathering more information. Scenarios can in this case be used to envision future developments, and also to understand what drives these developments (Börjeson et al., 2006). In this research the method of scenarios will be used to get an idea of what the mobility system including MaaS might look like, creating several possible futures. It also means being creative and thinking out of the box to go beyond the idea of extrapolating trends into the future, since this seems to be difficult to do for complex developments such as MaaS. Another used approach in scenario planning is looking at what is a preferred state of, in this case the mobility system with MaaS, in the future (Marien, 2002). This can be a helpful way of doing research in the case of developing policies to enable, steer and guide the MaaS developments in certain preferred directions. Both of these methods of scenario planning can be useful, for the one is focused on preferred end states and how to get there, whereas the other one is focusing more on the wide spectrum of possibilities and what drives them.

To get a deeper understanding of the development processes of MaaS it is necessary to study it in a more closely defined area, by means of doing a case study. This way the researcher will be able to look more in-depth at the processes and actors underlying the development. Therefore the development of MaaS has been chosen to study in a specific context which is the Dutch city of Groningen. This city has been chosen since the city indicated that MaaS could possibly be a solution to some of their problems and pose some possibilities for them (Gemeente Groningen, 2017). The city of Groningen indicates that it wants to be one of the frontrunners in smart mobility testing and development, also announcing that they were going to set up a Mobility Innovation Center (City of Talent, 2018). Besides, the mobility dynamic already present in the city is interesting, since the focus is more on bicycles than in other Dutch cities. At the time of the research the city already started doing some pilots projects concerning MaaS, so this indicates that it could be interesting to investigate the outcomes of these and their future possibilities in Groningen.

In the Dutch city of Groningen there is also some pressure on the mobility system. Generally the city is known for a high liveability (Gemeente Groningen, 2018). However, the traffic in the city center and ring roads are quite busy causing congestion and decreased air quality. Furthermore, due to growing population there is increasingly less space for parking and recreative purposes. Since it is a real student city there are many cyclists, and the government also focuses to a large extent on the bike as main inner-city transport mode (Gemeente Groningen, 2018). To make and keep the inner city more livable and clean the city is

planning on keeping more traffic out of the city center and focus continue to focus on good cycle routes. Smart mobility solutions can help with these goals. The local government has already started various projects concerning smart mobility, such as using and testing electric and hydro buses for public transport and installing smart traffic lights (Gemeente Groningen, 2018). Also, the concept of MaaS is in the startup phase in the city of Groningen. There are three pilots by which the city is already exploring the possibilities for it using pilots; (1) a bike-sharing pilot called *Bikeshare050*, (2) a car sharing service called *Witkar* and (3) having certain logistic transfer locations called *Hubs* (Gemeente Groningen, 2017). There are areas around the city of Groningen that are poorly covered by public transport services due to high costs. This also poses a point of attention. According to the government of Groningen MaaS would for example pose an opportunity for these areas city where public transport is more difficult to organize (Gemeente Groningen, 2017). Furthermore MaaS can help organize transport more efficiently, which contribute to the lessening of congestion. MaaS also promotes making use of shared transport modes, which can help with urban densification (Gemeente Groningen, 2019). Finally, MaaS can help with social inclusion, since it can contribute to a more efficient organization of target group transport (for people with disabilities).

Since the city just started exploring the possibilities of MaaS developments in the form of pilots, this could pose an interesting departure point to research what the future may hold for MaaS development in the city of Groningen. Implementing smart mobility developments, or in this case MaaS, comes with a certain amount of uncertainty, since the concept is still so new. Next to that, if it is to be implemented on a larger scale it will change the way the mobility system works profoundly and also change the roles of the actors involved in mobility services (Marsden & Reardon, 2018). This will bring about some uncertainty of who takes up what role, who has which responsibilities and how that will be organized and governed. These changes will eventually also have an impact on how cities in the years to come will be shaped (Docherty, 2017). Since the developments are progressing it seems that urban planning, mobility policy and infrastructure management will have to face the increasing adaptation of smart mobility practices like MaaS (Karim, 2017). To be able to get an idea of what the possibilities are for MaaS in Groningen, either solutions to current problems or threats and pitfalls that the concept may bring about, this research focuses on possible future scenarios regarding MaaS for the city of Groningen. The research goal is to give an overview of possibilities and development paths for MaaS, hoping that they will help policymakers to be able to anticipate on the changes to come, or to see the potential that MaaS may hold.

1.3 Research objectives and research design

Problem statement:

From the previous sections it became clear that there is a perceived contemporary growing pressure on mobility systems and because of that also on the environment, however MaaS can be a solution to deal with these problems.

Research aim:

However, from the previous sections it also became clear that MaaS still is a new and also complex development, which brings a lot of uncertainty about its future development. To help deal with this the decision has been made to use the scenario approach to develop scenarios that can also contribute to policymaking. The aim of this research is therefore to develop possible future scenarios for MaaS in the city of Groningen and determine policy recommendations that follow from these scenarios.

Main research question:

The central research question that this research will aim to answer is:

What are possible scenarios that Mobility-as-a-Service can generate in Groningen for 2030, and what policy recommendations can be made about them?

Secondary research questions:

To answer the primary research question the following sub questions will be discussed in this research:

- *How to define Mobility-as-a-Service from a theoretical perspective?*
- *What are the roles of uncertainty and governance with regards to future MaaS development?*
- *What are the drivers and uncertainties of MaaS development for the future in Groningen and what possible scenarios follow from them?*

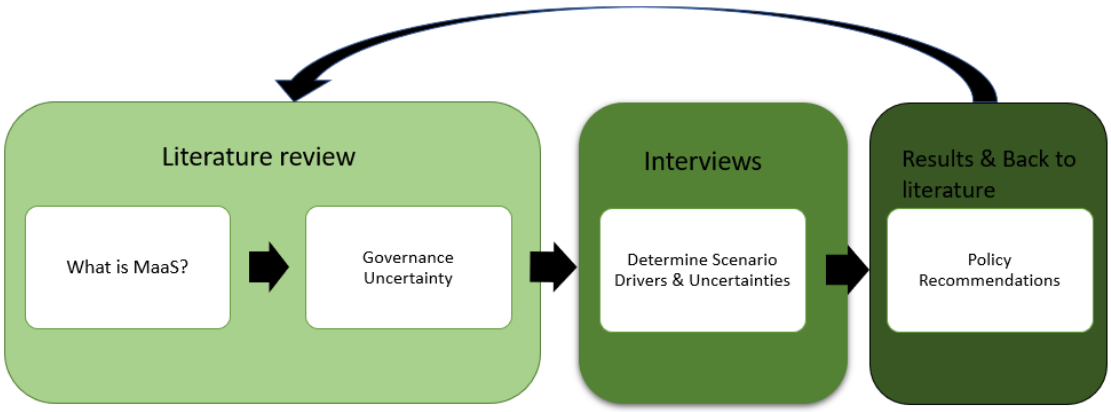


Figure 1.1: Research Design

From the above the following research design has been composed and is illustrated in figure 1.1. From the figure it follows that this research consists out of three parts; 1) **literature review** which is carried out to answer the first two sub questions of this research, 2) **interviews** with experts to determine MaaS drivers and uncertainties for the future and construct scenarios and 3) **results and back to the literature** in which the results will be tested against the theories used in chapter two and policy recommendations will be made. The goal of this research is mainly to explore the possibilities and using scenarios to do so. With this approach the aim is to draw lessons from them to help with policymaking and governance processes in the present-day environment.

2 Theory

This chapter will provide an overview of the relevant literature connected to the main research topic, which is smart mobility, specifically the sub development of Mobility-as-a-Service (MaaS) in the city of Groningen. First an explanation is given about what smart mobility entails. Then the concept of Mobility-as-a-Service within the smart mobility paradigm will be discussed. Subsequently the topic of governance and its role in relation to Mobility-as-a-Service will be elaborated on. Following from this the relationship between uncertainty and MaaS development will be elaborated on. This will then finally be connected to the scenarios as an approach to look into future MaaS development will be discussed.

2.1 Smart mobility

Smart mobility is a concept that has been introduced in the theoretical debate recently. It is a new way of making use of mobility, with a focus on ICT. Firstly, we move to some general assumptions about mobility.

Mobility: '*The ability to move or be moved freely and easily.*'
(Oxford Dictionary)

Adding to this broad definition mobility determines the extent to which people are able to participate in society, and are mobile enough in any way to do so (Nijhof, 2018). Other authors also refer to mobility in this broad sense to be simply the 'freedom of movement' (Flugge, 2017; Zanon, 2018). The reason that people want to be mobile, is to carry out activities in other locations such as work, or leisure. Next to that, there is also mobility for the transport of goods and products that customers need and want to buy. Mobility can then also be seen as a system of connections, which humans can make use of to create economic and social value. This system lies at the base of society and can therefore also be referred to as *'the fabric of society'* (Idenburg & Weijnen, 2018). However, the definition above refers to mobility in a broad sense. In general mobility can be divided into three aspects: (1) the psychological, (2) the economical and (3) the geographical (van Wee et al., 2013):

1) The *psychological* is about people's choices and motivations for using certain modes of transport based on their needs, opportunities and abilities.
2) The *economical* is about the choice for modes of transport on the basis of cost with regards to comfort, travel time or sustainability of the travel mode.
3) The *geographical* is about the limits in space and time that people have for being mobile. Meaning people have certain 'base' locations such as home that are fixed in certain locations and in time and these do to some extent also determine their freedom of carrying out other activities in space and time.

These three aspects are connected to each other, since choice for mode of transport is for example related to the price and the location/availability of certain modes of transport. This division of mobility in these three aspects is seen from the perspective of the individual. What Van Wee et al. (2013) also mention is that travel behaviour is a habitual process, which means that once people choose a certain way they usually commute to for example work, this habit does not change easily. In the book of Flugge (2017) it is even mentioned that changing mobility habits is almost as hard as changing religion (p. 246). However, there are

developments taking place that are likely to change the way the mobility system works (Docherty & Marsden, 2018; Sprei, 2018) . These developments are also named together as smart mobility developments.

From the literature the following elements seem to be part of Smart Mobility:

1) It is based around the use and deployment of (innovative) ICT as main component (Papa & Lauwers, 2015; Nemtanu et al., 2016; Rijkswaterstaat, 2019).

2) Electrifying vehicles using technologies such as battery power and plug-in hybrids. Furthermore the development of autonomous vehicles that may in the future lead to drivers becoming passengers, creating the possibility of doing other activities while travelling (Lyons, 2018; Marsden & Reardon, 2018)

3) Mobile internet being used for mobility purposes with the use of mapping technologies or real time travel information, and allowing a two-way flow of data and information (Flugge, 2017; Marsden & Reardon, 2018).

4) The infrastructure around mobility services is becoming increasingly more intelligent. In the future this may allow it to interact with users and vehicles in real-time to give them various sorts of information or incentives (Flugge, 2017; Lyons, 2018).

5) A shift is occurring from vehicle ownership to usership. People are increasingly using various services for car sharing, using ride-hailing apps or making use of more integrated mobility services targeted at the user like MaaS (Mobility as a Service) (Papa & Lauwers 2015; Jittrapirom et al., 2017; Smith et al., 2018).

6) Smart is sometimes used interchangeably with sustainable and does sometimes mean sustainable. However, they are not the same. They are often complementing to each other. Furthermore, if technology contributes to more sustainable modes of transport this can also be seen as smart. So, in some cases smart does also mean sustainable. (Noy & Givoni, 2018.)

This list is not finite, but it gives a quite elaborate insight in what according to the literature the most essential smart mobility developments entail. Lyons (2018) for example argues that the definition appears to be vague, ambitious or absent, meaning its definition is not always given but assumed to be understood. However, it seems that though smart mobility can mean various things and be subject to interpretation also depending on the context that it is used in, there is a need for it to be clearly defined become less of a buzzword or an umbrella term to be able to use it in research. In this research the main focus is on researching the future development of the smart mobility concept 'Mobility-as-a-Service (MaaS), which is a development that focuses on both vehicles, their technology and the system they are connected to. In Mobility as a Service, which will be explained later, the key elements turn out to be the focus from usership to ownership, and the (smart) technologies supporting this new development (e.g. real-time travel information, platforms, integrated payments), therefore incorporating points 1), 3), 4) & 5) of the definition of smart mobility above. Furthermore, a more social element seems to be of importance. The shift from usership to ownership is a behavioral change that characterizes MaaS, and can also be considered with regard to a more sustainable way of travel.

So, an approach to achieve a more sustainable mobility system would be to incorporate smart mobility solutions and behavioral change with regards to mobility choices made (Gironés & Vrščaj, 2018). Even though smart mobility developments are not in themselves always sustainable, they are able to contribute to a more sustainable transport system. As discussed before, technology and ICT play a main role in smart mobility. However, for technology to change the mobility system there is also a need for users to accept the new developments for them to be implemented. Furthermore, Lyons (2018) points out the need for mobility consumers to know and be aware of how to maintain their use of mobility in the long-term socially, economically and environmentally in the sense of being well-informed about the impacts of their mobility decisions. For the future this seems necessary if sustainability aims for the future are to be realized. This entails aiming for: *"meeting the needs of the present without compromising the ability of future generations to meet their own needs."* (Brundlandt Report, 1987, p.15). The mobility system would not be efficient or 'smart' in the long term if it compromises the future by for example an increased amount of traffic, or a completely electrified but large fleet of vehicles. Therefore, what has to be determined is efficient or smart to what end? Is it about every customer making as many trips as they want and with high speed, or should the focus be more on decreasing the amount of trips by also organizing the environment around it more efficiently on the long term? Current governance decisions determine the future and will therefore have a significant impact. Docherty (2018) for example points out that the smart mobility idea is often marketed as leading to less individual vehicles in the system and also less congestion helping with sustainability aims, while on the other hand from the economic perspective it seems that there will be more mobility per person, and therefore actually more traffic which can be unsustainable.

To achieve the smart and sustainable mobility aims various parties involved in mobility developments need to accept and believe in them to make the change. Elkington (1998) already referred to this in his concept of the triple bottom line. The triple bottom line emphasizes that for an idea or a business case to really be successful it needs to have support from the people, be good to the planet and be profitable. To do this, partnerships need to be formed between parties to get better results than when parties are operating on their own. This could mean that the government is working with companies, consultants, action groups or other groups or institutions in society. In these partnerships the parties have to search for ways in which they can use their strengths together to bring them to something even better to simultaneously create desired outcomes for people, planet and profit. Furthermore, the development needs regulation to make sure that a certain level efficiency and sustainability can be achieved so that one does not to a certain extent compromise each other. The process of guiding, steering or enabling these developments in a way is called governance and will be discussed more in depth in paragraph 2.5.

In some of the smart mobility literature there appears to be a focus on a shift from ownership (owning cars etc.) to a more usership (ride-sharing, bike-sharing etc.) centered vision on mobility (Flugge, 2017). This is also seen in point five from the definition list above, and is usually referred to as Mobility-as-a-Service (MaaS) developments. Since the focus of this research is on this particular development within the smart mobility domain, the following paragraph will be specifically focused on this.

2.2 Mobility as a Service:

MaaS stands for offering mobility services in a package tailored to a person's wishes. Furthermore, it increases the amount of mobility options the customer has, through creating a platform that allows users to access various travel options through one platform (Jittrapirom et al., 2017; Flugge, 2017; Smith et al., 2018). The business model that MaaS relies on is a specific type that is currently used in the personal communications market (Li & Voege, 2017). It can be considered the same as the Spotify platform for accessing a wide range of music, or the Booking.com platform through which all kinds of hotels are offered. In MaaS the same is done, but then for mobility options that can range from bikes, to cars, to trains or taxis from various providers offered through one MaaS platform. Hietanen (2014) characterized it first as a bundling of mobility modes in a package that is paid for by monthly subscription, therefore being substantially different from the contemporary, more ownership-based transport system (Jittrapirom et al., 2017). In the current system, different parts of a person's trip usually have to be paid for separately to different providers. The planning of trips also usually is done using different apps or websites. The shift in MaaS is towards a transport model which enables users to choose from a range of options on how to carry out their trip, also having the opportunity to make reservations in advance using just one integrated app or system (Flugge, 2017). Pangbourne et al. (2018) even go a step further in stating that the MaaS development also shapes possibilities for the future to make for example cinema or restaurant reservations together with planning your trip within the same app. They conceptualize MaaS as a combination of a platform technology (using for example an app) with a business model that delivers access to integrated mobility services (ibid.).

Since the intention of this research is to construct future MaaS scenarios for a specific place, which is the city of Groningen in the Netherlands, it is necessary to construct a framework for MaaS in order to research the concept in the given context. This will be challenging since multiple authors state that there is some ambiguity surrounding the concept of MaaS, and frameworks to systematically analyze it are not readily available (Jittrapirom et al., 2017; Pangbourne et al., 2018; Smith et al., 2018). Therefore, an overview of the main characteristics of MaaS is given in table..2.1. The overview used originates from Jittrapirom et al. (2017) since they already did a review of 12 conceptualizations of MaaS from the existing literature.

Table 2.1: Main characteristics of MaaS (Jittrapirom et al., 2018, p. 16)

Core Characteristic	Description
1) **Integration of transport modes**	The integration and adjustment of various transport modes such as public transport, carsharing, taxi services and shared bikes.
2) **Tariff option**	The option to choose to pay for monthly mobility packages, or be billed separately for each trip that is taken.
3) **One platform**	MaaS providers offer their services through one digital platform for booking, paying or making travel reservations.
4) **Multiple actors**	In MaaS services there are multiple actors involved; MaaS operator, mobility user, transport providers and possibly also for example governmental/regulating actors.
5) **Use of technologies**	MaaS uses digital technologies to offer their services, using the internet, smartphones, computers and services for online data and payment.
6) **Demand orientation**	The focus of MaaS is on the demand side. It tries to satisfy the users needs best and make mobility offers that see fit to those needs.
7) **Registration requirement**	MaaS users need to register before being able to make use of the service.
8) **Personalisation**	MaaS is targeted at the idea that each individual has different needs and wishes and tries to respond to them as efficiently as possible.
9) **Customisation**	Customisation enables uses to set and change their preferences if they want to, such as choosing the fastest trip or the most sustainable options.

Hietanen (2014), the founder of MaaS, developed a framework illustrating what MaaS can look like and which aspects of the mobility domain can be involved in it. The framework is displayed in figure 2.1.

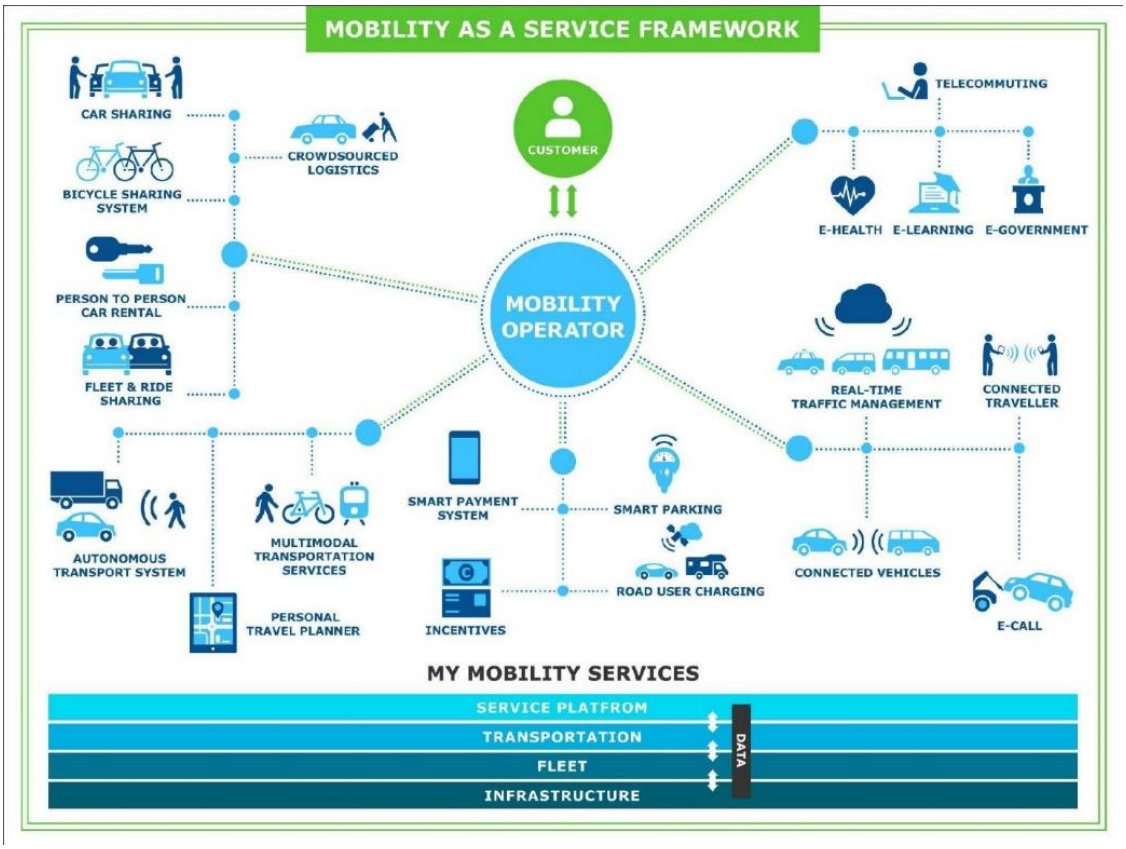


Figure 2.1: MaaS Framework (Originally from: Hietanen, 2014)

The general idea and the basics from the MaaS framework become clear from table 2.1 and figure 2.1. However, currently MaaS with all these services connected to it is in many cases more of an aspiration than reality. The framework for example is therefore a useful tool to explore possibilities, but not necessarily a an example of what MaaS generally looks like today. In most places MaaS development is still in its early stages, also in Groningen where this research focuses on.

From the literature there has been put together a scaling system to assess to what extent development of MaaS integration is present. This scale ranges from the levels 0-4 and is depicted below in Table 2.2

Table 2.2: MaaS' levels of integration (Sochor et al., 2018)

Scale	Integration level	Meaning
0	No integration	Single, separate services
1	Integration of information	Multimodal travel planner, price info
2	Integration of booking and payment	Single trip – find, book and pay
3	Integration of the service offer	Bundling/subscription, contracts, etc.
4	Integration of societal goals	Policy, incentives etc.

This table can be used to assess what MaaS developments are already taking place or starting to come into being. The level of integration is, as can be observed, focused on the integration of various MaaS functions. These functions also depend to a large extent on the interoperability of the systems that are connected to

the MaaS platform. In MaaS this entails interoperability between travel modes, vehicle types and types of data (Giesecke et al., 2016). This in turn also determines the integration level of MaaS in a certain place.

MaaS is researched here as being a possible solution for current problems that the mobility domain is facing. In this research two main problems with the mobility system have been mentioned. 1) Was the pressure on the mobility system, meaning too much traffic is exceeding road capacity, and also cities cannot take the amount of vehicles anymore. 2) Sustainability aims needing to be taken into account with regards to noise and air pollution. MaaS can pose a solution for these points in the following way:

1) Trips can be planned for more efficiently, therefore needing less of them (Sarasini et al., 2017). This affects traffic flows positively and also supports a decrease in emissions.
2) Sharing vehicles is promoted, which can lead to less parking space needed an less vehicles on the roads (Giesecke et al., 2016).
3) It can help offer mobility services in less well covered areas (Gemeente Groningen, 2019)
4) It can help socially less mobile people by using ICT to help them use mobility services (Gemeente Groningen, 2019)

However, there are also some things that need to be taken into account when implementing MaaS into a city. What is mentioned often is that the MaaS business model needs to be viable for it to be successful, meaning it needs to be sustainable on the long term (Giesecke et al., 2016). Furthermore, since the focus of MaaS is to a large extent also on moving towards a more sustainable transport system, this needs to be realized simultaneously with MaaS being economically profitable. Sarasini et al. (2017) mention that the sustainable aims of MaaS are to some extent regarded as public value. Therefore, for the business model to work both the public and the private value have to be captured and be profitable for the MaaS providers. And even if sustainability travel options can be offered through a profitable business model, there is also the question if mobility consumers will decide to use them.

As already stated in the introduction, changing the travel behaviour or patterns of people is not easy (Flugge, 2017; Sprei, 2018). Especially with MaaS, that is dependent on ICT, a premise for using it is for example knowing how to use ICT products and also be willing to. Also, for MaaS to achieve the intended goal of shifting from ownership to usership, the present attitude towards vehicle ownership has to change (Mulley, 2017).

Bamberg et al. (2003) conclude in their research that choice for travel mode is to a great extent a reasoned decision, that can be predicted by habit as long as the circumstances remain stable. However, when new mobility options such as MaaS arise this changes the mobility dynamic and options to choose from. For users to change their habits, which are the result of a reasoned decision, there needs to be an intervention that influence or changes in attitude, norms or behavioural control (Bamberg et al., 2003). These interventions can be tools carried out by governing institutions to help with a more widespread adoption of MaaS practices if they appear to contribute to solving the current problems of the mobility system. The need for governing with regards to MaaS has also to a great extent to do with the uncertainty that comes with it. The following paragraph will elaborate on this.

2.3 Uncertainty

'We cannot predict the future with certainty, but we know that it is influenced by our current actions, and that these in turn are influenced by our expectations.' (Pérez-Soba & Maas, 2015, p. 52)

From the previous section it becomes clear that the new development and implementation of MaaS is in need of sufficient governance in order to minimize its negative impacts and maximize its benefits. However, in the case of the implementation of MaaS, planners and policymakers are faced with substantial uncertainty. This stems partly from the fact that there are no statistics on the future and its development (Durance & Godet, 2010). Furthermore, developments such as energy transitions, sustainability transitions and with these the impact on transport development are inherently unknown, which is called 'deep' uncertainty (Marchau et al., 2010) So the question then is; how can planners and policymakers still govern processes such as the implementation of MaaS while facing these substantial amounts of uncertainty?

Lyons and Davidson (2016) state the following to shed some light on this (p. 105):

- The changes in the transport system (such as implementing MaaS) are uncertain because we do not yet know its cause and effect.
- To accommodate uncertain change such as this, there is a need for flexibility in the future design of ours systems and also flexibility in our thinking.

Lyons and Davidson (2016) focus on policymaking pathways that they mention can be a successful strategy to deal with uncertainty. Even though in this research uncertainty will be tackled by using scenarios to give insights in what futures are possible with MaaS, these assumptions of Lyons and Davidson (2016) do indicate that there is need for strategies to deal with uncertainty, and that the solution for this lies in specific forms of governance.

Rauws (2017) points out that there are always certain uncertainties that planners have to deal with. They can be managed by the use of the strategy of Adaptive Planning, which can be seen mainly as an addition to more traditional modes of planning. The approach argues for a shift from content and process, to conditions for development. This can also be applied to the implementation of MaaS. Both of the strategies above emphasize that there is a need for a certain amount of flexibility and openness, which is needed to adapt policy and governance to a (possibly) rapidly changing and dynamic environment (like the introduction of MaaS into the mobility system).

With the knowledge that the implementation of MaaS will bring about uncertainty about the future of the transport system, its governance, roles and actors, the question arises on how to anticipate on all of this. The development of scenarios has been used in doing research concerning future development. Since they help in dealing with uncertainty and complexity, they contribute to the making of decisions by defining solutions to potential challenges (Pérez-Soba & Maas, 2015). Furthermore, scenarios are also tools for planners to use when uncertainty is high to aid them with strategic decision making (Schoemaker, 1995). Therefore, in the next paragraph scenarios will be discussed as being a theory as well as a helpful tool to research the future possibilities of MaaS.

2.4 Scenarios

As has been mentioned before, in this research a choice has been made to study the development of MaaS using the scenario approach. The scenario approach falls under the category of futures studies. The approach has been widely used by companies, planners and policymakers alike (Deloitte, 2017; Shell, 2019; (Planbureau voor de Leefomgeving, 2019; WRR year). For these companies in practice, scenarios have been a tool that is used for future planning and strategic decision making. In the case of MaaS, this is also necessary, due to perceived uncertainty with regards to the future.

The purpose of scenarios is to broaden the perspective of planners or policymakers on strategic decision making for the future (Schoemaker, 1995). In one way or another, scenarios can help with thinking about future development, how to reach certain objectives in the future or think realistically about what might happen in the future (Börjeson et al., 2006).

Scenarios are also a tool to help with dealing with uncertainty that new developments like MaaS bring about. Perez-Soba & Maas (2015) explain that decisions now do influence the future and scenarios are known to be useful for strategy development in such uncertain times. However, scenarios are generally not likely to accomplish desired outcomes, since the future is open and can be subject to disruptive events (ibid). Therefore in this research the idea behind scenarios is to explore future possibilities and uncertainties to eventually assist in decision making. Schoemaker (1995) for example explains that scenario making is a planning tool that can be used in the following situations:

1) When future uncertainty is high relative to the ability to predict or adjust
2) When in the past a lot of unforeseen surprises have cost a lot of money
3) When no new opportunities are perceived or generated
4) When the quality of strategic thinking in the field is low
5) When a significant change is taking place or is about to
6) When there is a need for a common language and framework without implications for diversity
7) When there is a case of many divided opinions with many of them having merit
8) When competitors are also using scenario planning

Some of the points that Schoemaker (1995) makes also apply to this research focusing on scenario planning for MaaS development in Groningen. The points relevant for this research indicating that scenario planning can be a useful approach in this research according to Schoemaker (1995) are 1), 5), 6) & 7). Scenarios can be as said before helpful to stretch and focus our thinking, but they can also lead to biased outcomes as Schoemaker (1995) points out. Scenarios can make researchers look for confirming evidence that development is going in a certain direction, making it biased. However, even if that can be the case, scenario thinking can still help with the main goal of this research which is exploring possibilities for MaaS and stretching the thinking about its future.

Since there are different scenario approaches, it is necessary to define which there are and where the focus of this research will be. The oil company Shell has been using scenarios as one of the first companies to get more insight in possibilities and uncertainties for them in the future, but most importantly to make them think more broadly about what lies ahead (Shell, 2019). But scenarios come in many different types, depending on what it is exactly that needs to be researched about the future. Scenario typologies by

Börjeson et al. (2006) will be used since they made an overview drawing from different sources. From figure 2.2 it can be derived that there are three types of scenarios: (1) predictive, (2) explorative and (3) normative.

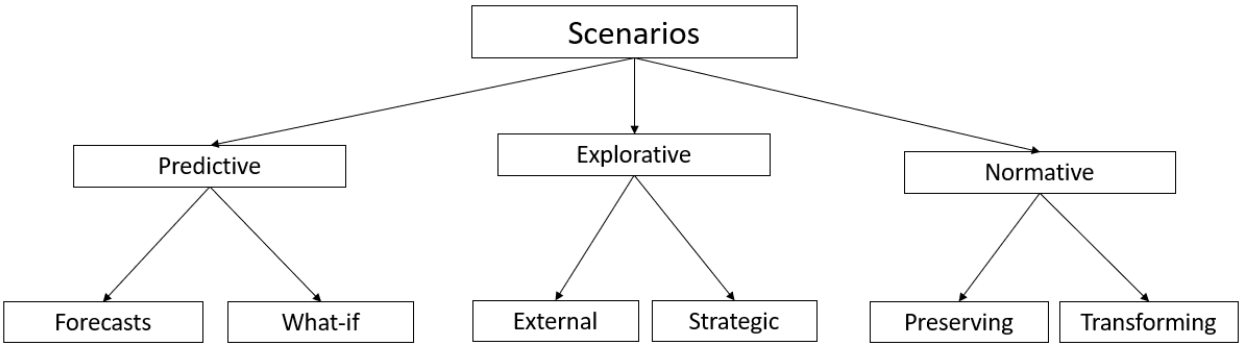


Figure 2.2: Scenario typologies (Börjeson et al., 2006, p.725)

Each of these then has two sub-approaches that can be used depending on what it is that the scenario is meant to be used for. In short, (1) the predictive scenarios that try to give insight in and actually even predict events in the future. Forecasts then are meant to investigate what may happen if a certain development unfolds, whereas what-if scenarios take a certain event as starting point and try to predict what happens if that event was to happen. Then, (2) the explorative scenario approach is very broad answering the question: *What can happen?* The external approach in this focuses on what kind of effect external factors may have, that are beyond the control of relevant actors. The Strategic approach focuses on a certain action that will be carried out and what possible consequences that action may have. And then finally the normative scenarios have a normative starting point and the focus is on how objectives or future situations can be met or realised by either preserving the way a system operates or transforming it when this seems necessary for reaching the objectives.

Marien (2002) also made a categorization of doing future study research using scenarios. He, however, calls them 'futures' studies, which seems to be used sometimes interchangeably with scenarios. The categories according to him are the following:

1) Probable futures
2) Possible futures
3) Preferable futures
4) Present changes
5) Panoramic views
6) Questioning

What he explains is that these categories are not leading in futures research, since even within categories there can be conflict. The distinctions between them are mainly in place to help with choosing an approach. He also mentions that good futurists consider more than just one category. What is important is that the nature of the research determines the type of scenario approach that should be used. In this research it has been mentioned that future possibilities will be explored, which would lead to the explorative scenarios from Borjeson et al. (2006) or the possible futures mentioned by Marien (2002). The difference between a scenario approach and scenario planning is the addition of a strategic aspect. In scenario planning as mentioned before by Schoemaker (1995) the goal is to use the scenarios to make strategic decision while

planning for the future. Making strategic decisions about the future to ensure certain outcomes or avoid others has to with governance. The next section will discuss this topic.

2.5 Governance

'*It has often been said that 'to govern means to foresee'.* (Marchau et al., 2013, p. 305)

The implementation of smart mobility developments like MaaS will entail changing roles and actors in the mobility domain (Dudley et al., 2017; Marsden & Reardon, 2018). To be able to deal with the changes that MaaS implementation will bring about there is a need for governance. That is, a process of steering, enabling or guiding these development in a certain direction to limit negative impact and ensure positive outcomes. But before going into this a more general definition of governance will be given.

Two important scholars with regards to governance are Rhodes (1996) and Stoker (1998). Rhodes article of 1996 titled 'governance without government' already to some extent indicates the main idea of it. discussed a phenomenon that he called 'new governance' by which he meant that governance has multiple uses. He already mentions that governance is characterized by self-governing intra-organizational networks that go beyond the government. Stoker (1998), who describes governance using five propositions (p. 18). From these propositions it becomes clear that Stoker (1998) just like Rhodes recognizes to distinguish governance from government. He points out that governance goes beyond government and that there are various actors and institutions involved in them, meaning that also action groups, companies or other non-governmental actors can practice a form of governance.

In the process of an implementation of MaaS benefits can therefore also only be realized if the transition is carefully governed by different parties involved (Docherty, 2018). Even from early modelling it already becomes clear that no amount of new and smart mobility using technology can overcome the need for policies, planning and governance (Ibid). It for example is of importance to determine the role of the state in this development since the providers of mobility usually depend on providing as much mobility as possible for making profit (Dochterty, 2018). There needs to be an actor to counteract this if other mobility objectives also need to be achieved, like equal access to mobility and not maximizing the amount of mobility limiting the amount of traffic for the sake of sustainability. Dochterty (2018) therefore mentions three reasons why there is a need to look into governance with regards to the MaaS developments that are taking place right now (p.25):

1) Already weak networks and systems of transport governance have the potential to be further disrupted by powerful new actors like global computing giants.
2) Consumers become providers too which complicates things, for example inequalities between people and their access to mobility can be polarized.
3) The government depends on them being in control cause they have the data, but in MaaS data is crowdsourced or from automated sensors, government cannot have control, so how to control this?

These are just a few reason that point to a need of proper governance of these new developments. MaaS is a development in which multiple parties are involved. Users, providers of transport services.

Following from section 2.3, in which uncertainty as a reason for governance has been discussed, it became clear that in uncertain development such as that of MaaS different approaches of governance are needed to be able to deal with this uncertainty and make robust as well as flexible plans for the future.

2.6 Towards a conceptual model

From the theory the following Conceptual Model has been put together which can be seen below in **Figure 1**. It represents the relations between the variables. On top there are possible future mobility problems and uncertainty that comes with them. Governance is a connecting factor here since it is needed to deal with the future mobility problems and uncertainty. How MaaS can be a possible solution to the problems will be researched through composing the scenarios using the drivers and uncertainties of the MaaS development. This will potentially lead to some policy recommendations that can be an input for governance for the future.

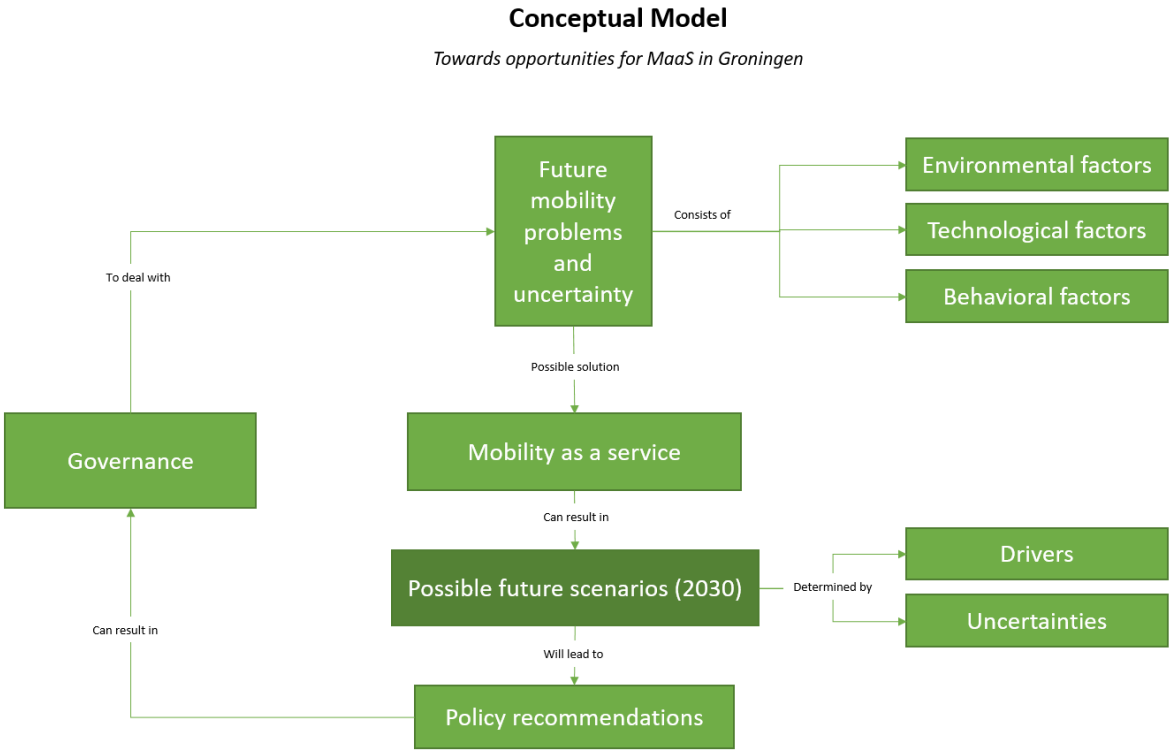


Figure 2.3: ***Conceptual Model:*** *towards opportunities for MaaS in Groningen*

3 Methodology

3.1 Scenarios as a research method

Studying mobility system related development entails studying events that could happen in the future. Therefore, the nature of this research can be considered explorative, because the development under study comes with a substantial amount of uncertainty. Due to this uncertainty, a suitable method for this research is using scenarios. A method that has been discussed before that is suitable for this kind of research is using the scenarios approach. In general, this method does not entail predicting the future, but constructing several different futures and the paths that may lead to them (Börjeson et al., 2006).

Scenarios provide a suitable manner to investigate the possible futures for Mobility-as-a-service, specifically in Groningen. In this research scenarios be considered a suitable way to investigate what possible futures may lie ahead for Mobility-as-a-Service, specifically in Groningen, and how these futures may come into existence. Due to the extensive use by various companies, planners and policymakers, using scenarios is an appropriate method for this research.The scenario method has been used by companies, planners and policymakers alike, which shows it is suitable for this type of research. For example, Shell is known to have been using scenarios to plan for the future since the 1970s (Shell, 2019). Moreover, the Dutch Planbureau voor de Leefomgeving (Netherlands Environmental Assessment Agency) makes use of possible scenarios for the future for example regarding demography (Planbureau voor de Leefomgeving, 2019). The Netherlands,has an independent board called the WRR, which stands for Scientific Board for Government Policy. The WRRis mainly concerned with doing exploratory research regarding policy for the future. Furthermore, the method has also proven usable in the case of studying the Dutch mobility system, or in this case, smart mobility development. For instance, Deloitte (2017) researched space gain in the city by using smart mobility, and scenarios that can possibly emerge from its development. , for example research by Deloitte (2017) about space gain in the city using smart mobility and the scenarios that can emerge from its development.

The importance of conducting scenario research becomes clear from the fact that planners and governing bodies need to make decisions now that will impact the way the MaaS development will change the mobility system for the future. Decisions made now will lead developments onto certain paths that can cause a 'lock-in' or path dependency (Marsden & Reardon, 2018). This means that decisions that are taken influence the amount of abilities for future development. To deal with this it is important to already consider what the future of the developments may look like.

In the theory section an overview was given about the different scenario types. In this research, the scenario method will be used to research possible scenario's. This falls into the category of explorative scenarios also shown in the figure 3.1. The scenarios in this research will incorporate strategic and more internal type scenarios since research has been focused on MaaS in Groningen and therefore should focus on both internal factors of MaaS development under the influence of external ones. These scenarios are explorative in nature and the type of scenarios that they construct are possible scenarios. This means that in the remainder of this research the term possible scenarios will be used to characterize this type of scenario. This scenario type will look at possible futures of MaaS and therefore answers the question: *'What can happen'?*

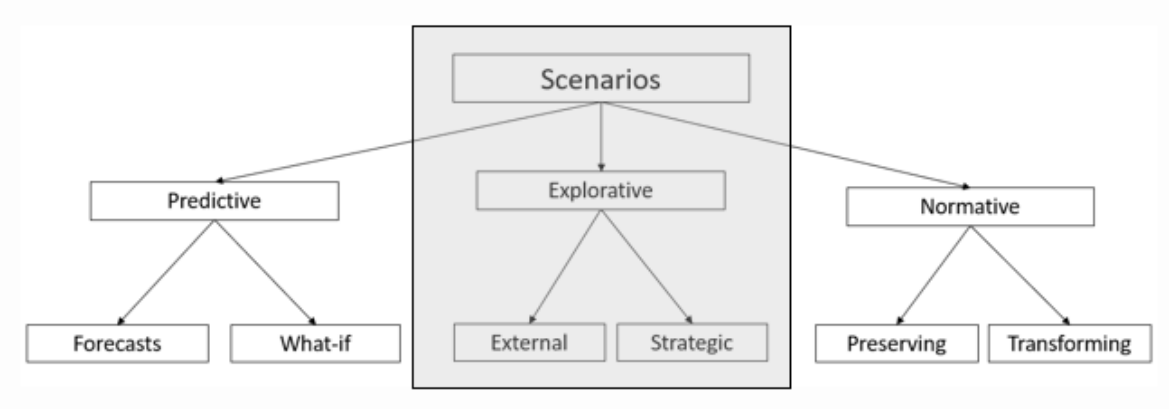


Figure 3.1: Explorative scenarios (After Borjeson et al., 2006, p. 725)

Explorative scenarios are suitable for qualitative research (Borjeson et al., 2006). In this case the research done is explorative and qualitative in a specific place, Groningen, making it a case study research. In the following section this will be further explained.

3.2 Case study – Groningen

From the introduction it already became clear that a choice has been made to focus this research on studying MaaS development in one single city,Groningen. This choice has been made because Groningen is already carrying out some pilots for MaaS and has stated the intention of investigating the concept even more. Boeije (2009) explains that in research a location has to be chosen in which can be learnt most about the research topic. Groningen therefore seems an appropriate choice in that respect.

The focus on a single case will be used in order to look more in depth at the specific case. A case study is a local manifestation of a broader phenomenon, in this situation Mobility-as-a-Service development in Groningen (Hay, 2010). The unit of analysis, or the case, is in theory determined by defining spatial boundary, theoretical scope, and timeframe (Yin, 2003). Case study research does not provide the possibility to generalize, as they can neither be entirely unique, nor entirely representative for a specific phenomenon (Hay, 2010). This is also the case with Mobility as a Service development in the city of Groningen. Therefore, the goal with case studies is to contribute to grounded theory, in which the aim is not generalization, but the deeper exploration of a certain phenomenon in a specific space and time (Boeije, 2009).

3.3 Time-frame

Given the aim of this research, creating mobility scenarios, it is necessary to a time-frame within which the research is conducted Since this research is about looking at mobility scenarios in the future, it is necessary to establish a time-frame within which the research is conducted. The reason that the choice for a time-

frame has to be well argued is to give the research validity. This means that the choice is based on methods, assumptions and logical reasoning (Kuusi et al., 2015). In that way choices can be justified by discussing them with others. Moreover, the idea of the scenario funnel needs to be taken into account. The scenario funnel refers to the following: the further away in the future we look, more possibilities are open or are there (ibid.). What also has to be taken into account is the idea of the scenario funnel, which basically means that the further away in the future we look, the more possibilities are open/are there (ibid.). The starting year of the scenario being the smaller side of the funnel and the wider side being the end year of the chosen time horizon. With time the amount of possibilities increases, therefore the funnel becoming wider. With high uncertainty developments like MaaS, the chosen time-frame should not be too long, since it would make the amount of possibilities too high. That would be beyond the scope and the time that stands for this research. The time frame that has been chosen for this research eventually is the present year (2019) till the year 2030. This is mainly due to plans the Government of Groningen has, with goalsset for the year 2030. Furthermore, on the Dutch National level a document from the PBL (Planbureau voor de Leefomgeving - Netherlands Environmental Assessment Agency) is also used as a reference for setting this time-horizon (PBL, 2015). In this document scenarios for the year 2030 and 2050 have been constructed for different societal developments including the mobility domain, which also makes it a fitting year of reference for this research.

3.4 Operationalization

In the paragraphs before the research method, spatial scope and time-frame for this research have been explained. In this subchapter it will be explained how this research method and the collection of data will lead to the input for answering the research questions that have been formulated. The subsequent steps are also visible in figure 3.2. In the following paragraphs these steps will be further explained.

Figure 3.2 Flowchart research operationalisation

3.4.1 Interviews

For this research the decision has been made to conduct a qualitative research. Because there is no solid data available to researchers about the future, what will happen with certain developments cannot be known (Durance & Godet, 2010). Therefore, for research about the future what is used as input are usually experiences and knowledge of experts about trends and developments from the past and the understanding of their cause and effect relationships (Davidson & Lyons, 2016). Eventually the choice has been made to conduct interviews with experts to gain insight in the main themes, drivers and uncertainties with regards to Mobility as a Service development in Groningen.

There are various ways to conduct interviews, from completely open conversations to very specific questions that are asked to every respondent (Boeije, 2009). The interviews in this research will be semi-structured, meaning that they are not fully open, neither having completely pre-determined questions. This decision has been made because some general questions about MaaS development in Groningen and the

future will be covered by every respondent, whereas every respondent also has its own context or and position in the work field which they speak from. Furthermore, with the construction of scenario's it is important to create an open conversation to and expand creativity to come to new insights (Pérez-Soba & Maas, 2015). Therefore the interviews have been structured along some main topics that each respondent was consulted upon.

The interviews have been held with experts of different positions with regards to the case study and also MaaS development in general to construct a representative overview of developments and insights on various levels and fields and organizations. Since Mobility as a Service is a new field of study, the decision has been made to select respondents by using the using purposive sampling. This sampling method is common to qualitative research and entails an intentional selection of respondents according to the needs of the study (Boeije, 2009). In this research the purposive sampling is based on the grounded theory approach, which means that the researcher collects data to generate theory. The sample is considered extensive enough when saturation occurs. This implies that consulting more respondents does not lead to new information anymore. More on the practical side in this specific research there were only a few experts present that could be consulted about the subject, this has mainly to do with the newness of the topic. Therefore the sample is on the smaller side. It is therefore plausible that consulting more respondents would in this case not have led to more and valuable information, but since this was not an option it could be said that saturation has been reached. Next to that, the research has been confined by a time constraint. In the table below an overview is given from the eventual list of consulted respondents.

Table 3.1: List of respondents interviewed

#	Respondent	Organization/project	Function	Place	Date	Duration
1	RES1	Triade, Healthy Ageing Campus. Bikeshareproject CampusCycle	Community-manager Campus Groningen	Groningen	6-5-2019	43 min
2	RES2	Municipality of Gronigen	Policy developer Smart Mobility	Groningen	7-5-2019	1 h 7 min
3	RES3	Province of Groningen	Programme manager Smart & Green mobility	Groningen	9-5-2019	27 min
4	RES4 & RES5	Province of Drenthe - National MaaS Pilot public and target group transport	Policy officer traffic and transport	Assen	16-5-2019	1 h 12 min
5	RES6	Kennisinstituut Mobiliteitsbeleid (KIM) & University of Groningen	Professor Transport Geography & Senior Researcher KIM	Groningen	24-5-2019	1 h 8 min
6	RES7	Groningen Bereikbaar: Bikeshare 050	Mobility management	Groningen	3-6-2019	57 min
7	RES8 *(non-recorded phone interview)*	Provincie Groningen & Drenthe - Drietachtig BV.	Programme manager Mobility Hubs project	Groningen	4-6-2019	28 min

The list of interview questions used for the semi-structured interviews can be found in appendix 1.A
The interview transcripts can be found in Appendix 1.B

The themes covered in this research and the concepts and their definitions that go with them are displayed in the table below. These themes will later on be used to structure the results section. They have also been used to cover leading themes in the interviews. In the table there has also been made a distinction between

concepts that emerged from theory and the ones that have been added because they emerged from the interviews.

Table 3.2: Operationalisation table

Operationalisation Table				
Category	**Concept**	**Sub-concepts**	**Definition**	**Inductive/ Deductive**
General	MaaS	General	Supply of multi-modal, demand-driven mobility services offered through a digital platform to customers. The payments and finalization of transactions are included.	From theory
		Shared mobility	The shared use of a vehicle such as bikes and cars or other transport modes	From theory
		Platform	A digital website or app (through which users can access MaaS services)	From theory
		Personalization	To take into account the personal preferences of users (in this case of MaaS services).	From theory
	Scenarios	Driver	A factor that causes a particular phenomenon to happen or develop	From theory
		Uncertainty	The state of not knowing what will happen (in this case with regards to a certain development in the future).	From theory
The following themes have been selected with regards to MaaS development (in Groningen)				
Strategic factors	Pilot		A small project that is carried out to test something	From practice
	Uncertainty		Not knowing what will happen	From theory
	Cooperation		Working together towards the same end	From theory and practice
	Incentive		A thing that motivates or encourages a person to do something.	From practice
Practical factors	Integration		Combining parts into a whole	From theory
	Money	Costs	An amount that has to be spent or paid to obtain something.	From theory
		Profit	The financial benefit obtained from a transaction	From theory
	Technology		The industrial use of scientific discoveries. In MaaS different technologies are combined such as data management, smart phones and computers, the internet et cetera.	From theory
	Degree of development		Determining the phase or state in which the MaaS development is	From practice
(New) Roles & Regulation	Public-Private		Cooperation between public (e.g. governmental) and private organizations (e. g. companies).	From theory
	Government		Group of people governing an organized community e.g. a state. This can be on various levels such as national, municipal or provincial.	From theory
	Market	Supply	The offering of goods or services.	From theory
		Demand	The need for goods or services.	From theory

	Governance		The process of governing (exercising rule or control over) a group of people such as a state or an organization.	From theory
	Regulation		A rule or directive maintained or carried out by an authority.	From theory
Behavioral and Personal factors	Acceptance		The process of recognizing a process or condition without wanting to try to change it.	From theory
	Visibility		How clearly an object or process can be seen and perceived.	From practice
	Habits (and the willingness to change)		A routine behavior that is repeated regularly and often subconsciously. Willingness to change habits is determining whether or not they can possibly be changed.	From practice
	Alternative		The availability of multiple options for choice.	From theory
	Convenience		A thing that contributes to an easy and effortless way of life.	From practice

The questions formulated for the respondents have been supported by the operationalization table 3.2. This table has been used to explain the concepts that have been questioned and discussed in the interviews. The concepts have been divided into categories, to structure them. These categories have been chosen based on the theory studied in chapter 2 and through the data and concepts emerging from the interviews in practice.

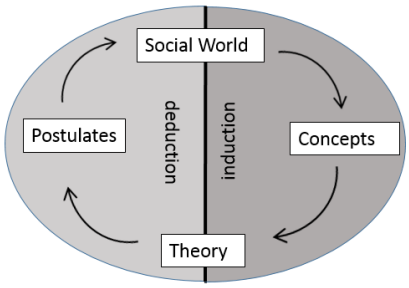


Figure 3.3: Case studies with cyclical modes of exploration

In case study research there is made use of a cyclical model that goes from studying the theory to testing it to the social world and then deriving new insights from that (Hay, 2010). The approach used in this research is similar.

3.4.2 Coding

In the data analysis of qualitative research, using coding is merely for the purpose of sorting, categorizing and analyzing the data and by interpreting them and making connections (Boeije, 2009). In this particular research qualitative sources in the form of interviews have been used and coded to explore different themes emerging from the developments in the mobility domain, specifically concerning Mobility as a Service in Groningen. To help with coding a computer program called ATLAS.ti has been used, which is a commonly used tool to for supporting qualitative data analysis with coding (Friese, 2014).

There are three types of coding that are generally used for processing interview data and these are open, axial and selective coding. In general, codes are linked to segments of the text to label them according to certain topics. Open coding has been used as a first way of organizing the topics emerging from the interview data. In open coding, no selection on the basis of importance has been made, since in this first step of the coding process it is unpredictable what will be of value and what not (Boeije, 2009).

After the open coding, the codes need to be reorganized to be able to draw some insights from the data. This is done through axial coding, which has also been named focused coding (Boeije, 2009). In this research this has been used to make connections between categories and specifying their properties. For example some codes are part of another code, some categories overlap and some codes are contradictory to each other.

The third category, selective coding, is choosing categories first, and then coding all the data fitting into that category into different subcategories (Boeije, 2009). In this research selective coding has been used to supplement the other two types of coding, since a small set of selective codes was needed to sort them into various categories with regards to MaaS. Two codes supporting scenario construction have been used while coding, these are driver and uncertainty. This has been done to assess which drivers and uncertainties were the most prominent to be able to construct the scenario and its axes which is one of the main research goals. How this has been done will be explained in the next section.

3.4.3 From data to scenario construction

To go from the collection of data to the construction of scenario's, the decision has been made to use the scenario axis model (van 't Klooster & van Asselt, 2006). This model is a classic form of scenario construction. In the interviews respondents have, next to other questions and topics, been asked what factors in the development for MaaS in Groningen till 2030 can be seen as drivers, and which of those are the most prominent and uncertain. The selection of the final drivers for the axis in the scenario construction has been done by analyzing what drivers have been mentioned the most in the interviews and why, or also by determining factors that have been most debatable or contentious. The axis technique is appropriate since it is used as a tool to help 'structure the unknown', which means it is relevant to get insight into future development (van 't Klooster & van Asselt 2006). The template that is used for this is illustrated below in figure 3.4.

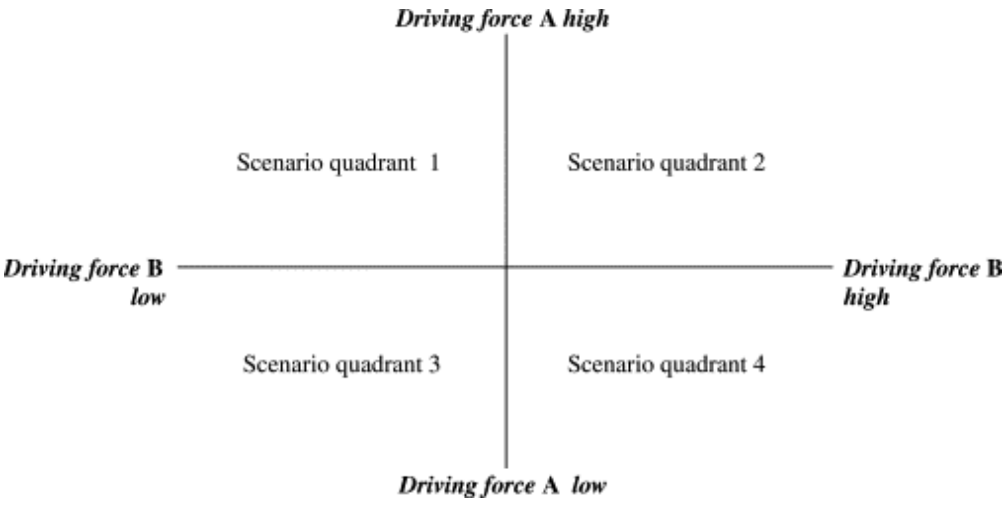


Figure 3.4: Scenario axes scheme (after: van 't Klooster & van Asselt 2006, p. 18).

Using this axis model, the four scenario quadrants will be drawn up after selecting the two driving forces that follow from the interview data. Meinert (2014) explains that the driving forces that make up the axes should be uncertain and prominent, but also most importantly be encompassing and overarching themes that other uncertainties can be grouped under. This will also be taken into account while determining the two axes. The four quadrants in the scheme will serve as four individual scenarios, that all have a corresponding storyline about how the future in that scenario may unfold (van 't Klooster & van Asselt 2006). The storylines will be based on the scenarios' position in the scheme (driving forces high or low) and the information gathered from the interviews. However, the storylines are also dependent on the view of the researcher and his interpretation of the information presented to him. This should be kept in mind while reading the scenario storylines. This connects to the scenario theory, which has been discussed before, about explorative scenarios. They are used to explore possibilities and broaden the view on how the future may possibly unfold.

In this research six steps have been used to structure the scenario construction process. These steps have been taken from a scenario construction manual by Meinert (2014). The six steps are:

1) **Approach the research question and the time horizon:** The research question is about MaaS in the city of Groningen. The chosen time horizon is the present until 2030. This has been decided in the previous chapters 1, 2 & 3.
2) **Identify uncertainties and drivers:** In this research this has been done by determining the drivers and uncertainties through the interviews and the literature.
3) **Describe the future alternatives that the two most important and uncertain drivers pose:** This entails developing the four extremes of the scenario scheme in figure 3.4. These are generally two opposing values. The driving force is high or low – or it is growing or declining.
4) **Making a 'future compass' out of the results**: In this research this is done by plotting the two drivers on the previously presented axes scheme in figure 3.4.
5) **Constructing scenario storylines for each quadrant:** In chapter 5 this has been done for each of the four quadrants, which make up the four scenarios. The storylines have been fed with information from the theory chapter 2, and the interview input.
6) **Reflecting on the outcomes:** The reflection on the outcomes has been done by a general discussion about the outcomes and their meaning. Furthermore, a SWOT-analysis of each of the four scenarios has been carried out to be able to make policy recommendations, which also is an objective of this research.

The last and sixth point, the SWOT-analysis, is done to be able to make the bridge towards policy recommendations. The SWOT analysis will be explained in further detail in the next section.

3.4.4 SWOT

Following from the previous section, a SWOT-analysis has been chosen as a tool to help with scenario analysis and eventually the making of policy recommendations. The SWOT-analysis is the most widely used tool to support strategy development (O'Brien & Meadows, 2013). Since the aim of the research is to conclude with some policy recommendations, the SWOT has been used to help achieve this more strategic aim. SWOT stands for Strength, Weakness, Opportunity and Threat. Swot is a tool originally derived from the business domain , in order to distinguish the development of a business or company for the future and manage uncertainty (Chermack & Kasshanna, 2010). Even though, in the more general scenarios that have

been constructed in this research cannot be allocated to only one organization, the SWOT matrix helps to assess the internal strengths and weaknesses, and the external threats and opportunities for the MaaS scenarios in this case in the specific place of the city of Groningen. These factors together have been used to more systematically say something about the storylines of the scenarios and their drivers. An example of a SWOT matrix is given in table 3.3.

Table 3.3: SWOT matrix – example (Author, 2019)

	Internal	
	Strength	*Weakness*
External	*Opportunity*	*Threat*

3.5 Ethics

Qualitative research is subjective. There are no conflicting ethical issues present in this research. However, it is important to keep in mind differing perspectives of respondents. The information collected from interviews cannot be a direct representation of events, only a story colored by the person that witnessed it (Boeije, 2009). This will be taken into account, while working with the data gathered from the interviews. Moreover, reliability and validity are to important factors to be kept inmind while conducting scientific research. Two other important factors to keep in mind while conducting scientific research are reliability and validity.

Reliability has to do with the consistency of the measures used in (social) research (Boeije, 2009). In this research, partly asking the same questions to each respondent will ensure reliability. reliability will be strived for by having a questionnaire that partly asks the same questions to each respondent. However, since it is a case study in which different types of experts will be consulted, the questions could not all be the same for all respondents. Due to time constraint, unfortunately, there has not been room to interview each respondent twice, which would have increased reliability. This must be taken into account when considering the current reliability of the research.

Validity, is regarding the researcher being specific towards what it is that will be assessed (Boeije, 2009). In this case, regarding internal validity, the research describes what it sets out to describe (ibid). Moreover, it refers to objectivity and awareness of information not being revealed by respondents. This is also about being objective and aware of information that is not revealed by respondents. In this research, no indication was given by respondents of withholding certain information. that information was kept silent about by respondents. However, some respondents indicated to not be able to give full detailed information due to professional secrecy. For internal validity the concepts that have been considered to be important have been explained in the operationalization table. These served as a basis for the coding process later on. The codes emerged from both theory and the interviews, and deemed important if they were mentioned multiple times.

4 Interview results

In this section, the data resulting from the interviews are presented. The results and explanations will be supported by quotes from the respondents. Quotes have been translated by the author of the thesis since the interviews have been conducted in the Dutch language. While translating, the actual message of the respondents has been tried to be conserved as well as possible. First of all, a few larger categories and themes regarding to future development of MaaS in general and in Groningen, emerged from the interviews, are discussed here. MaaS future development in general and in Groningen that have emerged from the interviews that will be discussed here. These have already been mentioned before in the operationalisation table 3.2 in section 3.4.1. The categories have also been chosen on whether or not they have been more extensively discussed in the interviews. The main themes within which these categories can be classified are displayed in table 4.1.

Table 4.1: Themes emerging from the interviews

Theme	Explanation
Strategic factors	These concepts relate to the overall long-term aims with regards to MaaS development and their influence on achieving them
Practical factors	These concepts influence and relate to the actual use of MaaS in practice.
(New) Roles & regulation	These concepts describe the (new) institutional roles and regulations that are involved in MaaS development.
Behavioral and social factors	These concepts relate to factors influencing the individual user level and the societal level of MaaS development.

Strategic factors

1. Pilot

In this research, a few respondents that were involved in pilots with regards to MaaS (and other Smart Mobility developments) have been interviewed. The pilots, at this time, seem to be a way for several factors such as companies and governmental parties to explore this new mobility terrain. They form partnerships within these pilots to be able to learn from it and set standards together. Through the pilots, knowledge can be generated about what does and what does not work, so there is room for experimenting. However, the ultimate goal is that eventually something comes out of the pilots that can be carried out on a larger scale.

Sometimes, the respondents, mentioned pilots taking longer than expected because they encountered unexpected hiccups [RES1, RES4, RES7]. However, these hiccups also turned out to be lessons that they can take into account when the projects go from pilots to real implementation. One pilot was also part of a nationwide MaaS programme:

'What you actually do with MaaS is putting another layer over the existing one, and that is the quest that the ministry has. And they try to figure it out through a national MaaS programme that we are part of. The idea in the end is that through the national pilot projects they work towards a few national MaaS suppliers. But in the pilot they strive towards an level playing field, because it is undesirable that all kinds of parties start to offer MaaS services by themselves.' [RES4]

The pilots in the city of Groningen in particular were to a significant extent focused on projects with bicycle sharing systems. This makes sense since within the city everything can be accessed by bicycle and Groningen is also called a bike-city [RES2].

2. *Uncertainty*

In the research, uncertainty has been discussed before as being inevitable with new developments. Moreover, the need for research regarding developments to manage uncertainties have been mentioned. The above mentioned, pilot has been discussed by respondents from the interviews as a way to get a grip on what uncertainties MaaS brings about and what barriers and opportunities it holds. Various respondents have made statements about this:

'We now see that the whole hype with the shared bikes has collapsed a bit, some suppliers went bankrupt.' [RES7]

This first quote shows, the dependency on a new development being a hype can be connected to uncertainty. The experimenting with it in the form of a pilot project enables this in a safer way. Furthermore, the interaction between different factors can pose uncertainty, especially when all the factors intrinsically contribute to the uncertainty:

'That is what I always find difficult. The industry makes something or delivers the technology, the consumers or the citizens need to want it, and the government also does something and that is always a kind of difficult interaction' [RES6]

Finally, actors mentioned uncertainty with regards to the acceptance or willingness of actors to try and change to MaaS-related transport options [RES1, RES2, RES4, RES5, RES6, RES7].

3. *Cooperation.*

The previously mentioned pilots, carried out in Groningen, provide new insights in what works with MaaS practices and what does not, and it also forms a base for cooperation between actors. Cooperation has been mentioned in the interviews and identified as parties working together in MaaS development. That turned out to be important for several reasons:

'What is very important from the side of the government is, even if it is the market leading the development…if you let the market regulate itself you will see that one large player remains.' [RES4]

In particular the respondents in Groningen, mentioned an increase in cooperation between different parties to share knowledge, and go towards achieving shared objectives. The respondents mentioned in Groningen in particular that there was an increasing cooperation between different parties to share knowledge and go towards achieving shared objectives [RES2, RES3, RES6, RES7]. This also follows from the next two quotes by RES3:

'Therefore we (the province among others) are in the process of founding the mobility innovation centre (MIC, now known as hive.mobility, with the idea that companies are also going to join in. In the meanwhile there are already 15 till 20 companies that showed their interest and want to cooperate. So right now it has already become a cooperation between governments, knowledge institutions and businesses.' [RES2]

'As government we can more easily take risk, because if it goes wrong, we do not immediately go bankrupt or something. So I think it is important that the government should step up and help these innovations get started.' [RES2]

Also, cooperation between parties can support maximizing multiple objectives of MaaS development, public as well as private.

'Clearly there are more companies that are involved in the development and start-up of MaaS as market parties and they want to get started with it. And at a certain point you (local government) have to have a case with regard to MaaS, and you have to do that together with market parties because you can't do that alone, so that also has to be in cooperation with the users and the government… We are of course on the regulatory side here. So therefore we have to regulate, but we also have to work towards a cooperation in which we maximise opportunities and set up actions to do so effectively .' [RES2]

4. *Incentive*

Incentives are triggers for users to do something or change behavior, in this case with regards to MaaS. Incentives have been mentioned quite often in the interviews with the respondents.

1) As something necessary for people to change behavior [RES1, RES].
2) They can be and are used by government or by employers to change travel behavior [RES1, RES7].

'…and so the travel behavior that changes within companies, follows mainly from measures and means the employer takes and offers.' [RES7]

3) They can be in the form of rewards, restrictions or other forms of regulation [RES2, RES7].

Incentives can help with making people change their travel behavior and eventually be inclined to travel differently or start using MaaS travel options.

Practical factors

1. *Integration*

Integration meaning combining and interlacing different travel modes (in the case of MaaS) and suppliers with each-other, has been a concept discussed in the interviews. The things said about it were twofold. MaaS poses opportunities for integration, but to achieve it there are many barriers to overcome. This led even to questioning whether in some cases it would be possible or it would happen at all.

'*What do we do with parties that already have shared bikes for their employees like the hospital or the municipality, because they are interested to have smart locks on their bicycles as well, but they do not want hospital employees to use the bikes with the red logo from the municipality.'* [RES7]

2. *Money*

Costs have also been a larger emerging theme in the interviews. Both costs for users, as for suppliers seem to be of importance meaning there are different interests on various levels. For the city RES7 for example said: *'We want to keep the city economically attractive.'*
Furthermore, with regards to a hub project in the region of the provinces Groningen and Drenthe, which has more to do with the connectivity to the city from the more rural areas, the same respondent said:

'With this project the rides become shorter and also cheaper.'

Next to the general costs and the drive to decrease them, costs on a personal level also matter with regards to mobility.

'Price is also a very important thing. A car is in itself quite expensive, but most people tend to look only at the out-of-pocket costs. So they only look at the costs for fuel for example. After a while they do not count the costs for purchase and depreciation anymore. [RES6]

From this quote it can be observed that the perception of costs is also important. Furthermore:

'If you look at WHIM for example in Finland, a monthly subscription for a full package there costs about 400 Euro per month. I actually find that to be a big hurdle.' [RES6]

Even if something, such as a car or a bicycle, has been an expensive investment at first, from the interview it follows those costs may eventually not be counted anymore. Whereas a monthly subscription to shared cars, bikes or just a mobility as a service subscription has to be paid over and over, which can make it feel more expensive.

Specifically RES3 mentioned two problems that are directly related to costs of the mobility system now within the city and between the city and the more rural areas. He said:

'We have two problems here in the field of public transport. One is that within the city a lot of money goes to reinforcement rides [meaning that at busy times there are two buses needed at the same trajectory to transport all the passengers]. On the other hand between the city and the rural areas it is becoming almost impossible to maintain some form of public transport, which also costs a lot of money.'

This indicates the earlier stated difference in problems within the city and between the city and the rural areas. Furthermore this indicates that money is an important factor with the problems in both cases. Therefore a new more integrated and efficient form of transport like MaaS can in both cases pose an opportunity.

But, in contrast to that. Even if this is the case it can also generate new problems.

'There are private parties and also governmental parties with different interests. For us that is for example difficult since we are responsible for the revenues for public transport. So if MaaS eventually does become

big that can mean that more money needs to go to public transport, because many different choices will be made there.' [RES4]

This does not mean that the opportunities will outweigh the new problems that they pose. However, even if MaaS can make mobility more cost efficient, it turns out it can for some parties also bring about costs. The parties that are mentioned to see the most benefit from MaaS practices are market parties. And while the governmental organizations also seem to have to deal with costs and profits in a way, they tend to focus more on the general benefits for the population. The government the government seems to be holding back a bit more with regards to MaaS development, which also follows from this quote:

'Because it is unsure if it (MaaS) can have value for the ambition that you have as a government, and market parties see it as a model for revenue.' [RES2]

3. Technology

Technology plays a substantial part in MaaS, characterized by a digital platform and its services. When asked about the technology one respondent mentioned that the technology would according to them not be the problem, and the technology needed for MaaS is already there [RES2, RES6]:

'With regards to MaaS I have the impression that the systems that are necessary to book and pay on such a [MaaS] platform, that they already exist and can be built already.' [RES2]

However privacy and security are important factors that need to be ensured too [RES2, RES4].

Furthermore, the integration between different systems is sometimes also dependent on datasets and working with different programmes [RES4], and it can be time-consuming or difficult to standardize.

4. Degree of development

With degree of the development it has been explained in the previous chapter that this was about the current development of MaaS. What do the respondents foresee with regards to the developments and what do they think is likely or possible in that respect. This is important, since it gives an indication of the opportunities and the estimations that experts make about its development can help determine the future course of action. The answers to this seemed to be kind of twofold:

On the one hand all the respondents indicated many possibilities that MaaS could offer. On the other hand, they also indicated that there are a lot of uncertainties, and barriers to overcome when implementing MaaS.

Even though MaaS is a new development that can seem promising, daily reality or patterns sometimes seem hard to break and can threaten the ability for MaaS to make a change. These for example have to do with money (how to pay for MaaS?), integration of various transport modes and systems, acceptance and more. This is also confirmed by the following quote:

'If I see in daily life, also in the Hague where I work, how many people travel only by car or take the car for short distances. Well, it seems that a lot has to change in a short time if we want to achieve the big change (to MaaS/smart mobility).' [RES6]

From this quote it becomes clear that MaaS has potential but it continues to be uncertain if the developments will come through more substantially. Respondents mentioned that in 20 years maybe existing initiatives (like NS business card or Mobility Mixx card) would have more integration, and different systems will be connected to one another [RES6]. But higher levels of integration, like level 3 or 4, will be difficult to reach and not likely to be in place in 2030.

(New) Roles & Regulation

1. *Public-Private*

With the concept or code of public-private the cooperation between market parties and governmental organizations is addressed. With regards to MaaS there seems to be an emerging cooperation between these two following from the interviews.

In Groningen an example of this is Public-Private is the establishment of the Mobility Innovation Center (MIC), which is now called hive.mobility after its official kick off. This center has been mentioned by various respondents, and it is an initiative started by the local government (RES2, RES3, RES6, RES7). With the center the aim is to share mobility knowledge between the local government, provincial government, school institutions and businesses. The center has only been officially opened in July, therefore unfortunately in this research not much can be said yet about projects or the benefits of this cooperation. However, it is a good example of new partnerships forming in development that brings about uncertainty, since it makes more efficient use of knowledge and the parties together can spread risks that come with new projects among them.

2. *Government*

Government, as has been defined from the literature, plays a role in the MaaS development. In Groningen it became clear from the interviews that government could be seen as a unity but sometimes also contradicts one another on different levels or in different areas [RES4]. There are various roles the government can take on in different situations.

Furthermore, the role of the government has mostly been characterized by respondents as helping in the start-up phase of the development [RES2, RES3, RES4, RES7]. Doing this also resulted in the forming of partnerships and working together with private parties.

3. *Market*

This subsection is about the role of market parties with regards to MaaS. They are generally opposing public and more governmental parties. With regards to MaaS it becomes clear that currently it is mostly the market that is taking the lead in its development [RES2, RES4]. That is mostly because they think MaaS can generate revenue. That also becomes clear from the following quotes:

'Right now it is mainly the market that is talking a lot about MaaS, so mostly market parties, and the government is doing that only very limitedly. That is mainly because it is not sure yet if MaaS can have

value for the ambition that you, as a government, have. Market parties however consider it as good model for revenue.' [RES2]

'Well look, at the moment that you as a market party want anything [also with MaaS], it may not always be the most important thing, but you would always want to make money, which is logical since that it why you are a market party. [RES4]

However, making revenue is not the only objective that MaaS can achiever. In this research also the potential of MaaS for public aims such as more efficient travel and sustainability have been mentioned.

4. Governance

In the interviews it became clear that governance was almost always mentioned together with government. This can also have occurred from the fact that among the respondents there were quite many governmental actors. However, in theory we have seen that governance can also be carried out by non-governmental actors.

About the governance process a few things were said by the actors. Governance according to the interview data and the respondents had to do with:

1) Providing incentives and stimulating certain (travel) behavior [RES1]
2) Facilitating MaaS development (through for example financing or giving permits) [RES3]
3) Regulating by for example setting rules or request certain requirements. [RES2, RES4]

The last point will be explained further in the next section about regulation.

5. Regulation

Usually done by governmental organizations like governance but then with more specific measures such as taxes, laws, rules among other things. With regards to MaaS development regulation has been discussed as:

On the one hand necessary to make sure the development goes into a preferred direction. But, on the other hand due to uncertainty a problem can be to decide on how to regulate. This has also mentioned to cause tension when regulation possibly hinders development by not providing enough space for new initiatives to develop [RES2, RES4].

Behavioral and social factors

1. Acceptance

The general acceptance of MaaS practices has been one of the mentioned themes that occurred in the interviews [RES1, RES2, RES4, RES6, RES7]. For MaaS to be used more widely people have to want to use its service. This has to do with people's perception of this new way of travel. Furthermore, this acceptance does also have a lot to do with experiences and whether or not people come in contact with Mobility as a Service practices. And finally this also has to do with the convenience/easiness of the usage of the Mobility as a Service travel options:

'If you have your own car you also have your own stuff, I for example have a child seat and I can always take my dog with me with the car and I have it readily accessible in front of my door. But if you would use a shared car that can become a problem because you would always have to transfer the child seat and it is not desirable that you put a dog in the back of a shared car. [RES1]'

So that means that the situation of a person is determining if they would choose to start using MaaS travel options. In this case there are quite some barriers that need to be overcome due to the situation for this person to start using MaaS travel modes. Another thing mentioned by one of the respondents was that people were more open to using new modes of travel in general after a change of work or moving to another home. RES7 talked about a research that they carried out about why people choose to change the way they travel:

'From our research there are two things that influence the travel behavior of people. One happened to one-third of our respondents; they experienced a compelling-event such as moving to another place or changing jobs. The other thing, responsible for about 50% of the group in our research, is a culture change within the company that someone works at.'

From this quote follows that acceptance and also changing habits are a personal thing but they can be influenced through regulation or they will change due to certain events. So if companies would change their travel options for employees or advertise for MaaS type of travel modes this could influence or enhance acceptance for them.

Finally, even if MaaS were to be a good fit and cheaper than travel is now, which would suggest it makes it more likely to be accepted, there is another factor that emerged from the interviews that influences acceptance:

'Even if MaaS becomes cheaper, it is possible that people just prefer to travel from door to door and preferably with as few people as possible. Since people generally also appreciate their privacy.' [RES6]

2. Visibility

The visibility of MaaS travel options is one of the important factors for whether people know about its existence. From the interview it followed that in a case with a self-driving vehicle people were more inclined to try travelling with it if they had seen or heard of it before:

' That [technology barrier] is an important reason why we have already started with pilots, because you can see that especially elder people have some hesitation to for example board such a vehicle [with regards to a pilot with a self-driving shuttle].' [RES3]

The respondent indicates the urge here to show or make the new developments visible in order for them to be accepted and adapted more easily. Here it was about visibility as well as guiding people through the process of getting familiar with new technologies. Also other respondents mentioned the urge of creating some visibility for the developments to familiarize people with them helping to become accustomed to new developments [RES2, RES7].

3. Habits (and the willingness to change)

Another factor that mainly is of influence of the adoption of MaaS travel options by users has to do with habits, and the willingness to change these. This of course has a relation to a persons' specific situation with regard to work, family, where they live, but also on a personal level to how open they are to try new things [RES1, RES2, RES6, RES7]. Form the interviews it became clear that some groups of people are more inclined to use new modes of travel or can do this more easily. For example; if you do not yet have a car it will be easier and a smaller step for you to go for a car-sharing travel option then when you have a car, use it every day and are already quite dependent on it.

'*Someone that is used to always having his own car, would he consider using carsharing? Of course not! A car is already quite expensive in itself and he has to get rid of the car to start using this new system.'* [RES2]

This indicates that habit is tied to other factors like convenience/ easiness. Another factor that is connected to it is costs (which will also be discussed in the next section about practical factors). RES6 said about this:

'[with mobility] There is a lot of habitual behavior. So with MaaS people then one way or another have to be triggered to start using it, and it should also be cheaper.' [RES6]

So here the respondent shows that there are multiple factors that are tied to the willingness to change their travel or mobility behavior, which also applies to MaaS travel options since they differ somewhat from the existing travel options.

Furthermore, generally throughout the interviews respondents indicated that from the first pilots it became clear that certain groups had more potential for adopting MaaS than others. In particular younger and higher educated people were mentioned to be more likely to use new/MaaS travel options.

'Research from KIM [the Dutch knowledge institute for transport mobility policy] found in their research that right now it are mainly young, highly educated and politically left oriented people that want to make use of MaaS, and then there are also large groups of people that are fine with sitting in the car all-day.' [RES6]

4. Alternative

Another theme emerging from the interviews was the general idea that MaaS can pose an opportunity in the way that it offers the users alternative travel options. From the operationalization table this has been defined as having multiple alternative travel options available. From the interviews this has been confirmed to be an opportunity of MaaS by multiple respondents.

In general respondents reacted to the general idea of MaaS as an alternative or more personalized way to travel.

'Imagine that you have all suppliers of transport in a MaaS system with shared bikes, public transport bicycles (OV-fiets) and the lot. So if you for example would then want to travel from Groningen to Vinkhuizen by bike, it would be possible that you could get like 10 different options for that.' [RES5]

Here it becomes clear that this option of alternative travel options is seen as a benefit or opportunity that the user could then choose from. Eventually RES4 also mentioned that this also has to do with a larger development in society that personalization is becoming more the norm. He said:

'But nowadays.., well it is more and more possible to travel by personal preference. And you also see in a lot of other branches that consumers are becoming increasingly demanding. At a certain point they do not accept it anymore that they simply get an offer, they do not like or accept that if they want something else.' [RES4]

5. Convenience

Convenience and easiness have been described as something being easy or doing something because it is an obvious choice because it has benefits over other choices. This matters with regards to MaaS because it is an alternative way of travelling. The convenience of it may be determining whether it will be adopted by users more widely.

Convenience with regards to MaaS mostly to do with the easiness of using the service. It has to give the user some kind of easy use and comfort and the transfers between various modes have to be easy to make [RES6].

'A transfer, we know this from research, is not pleasant for people. So to improve that you have to strive for 'seamless' transfers as they call it, meaning that your transfer is easy and not too much of a hassle.' [RES6]

Furthermore, if you want to use such services you would want them to be available, so if you make use of vehicle sharing subscriptions it has to meet this need [RES6, RES7]. Finally, MaaS travel options have to be able to meet the needs of someone's personal situation. If you have for example a family and pets you would want the service to be tailored down to this situation making travelling with it easy [RES2].

5 The scenarios

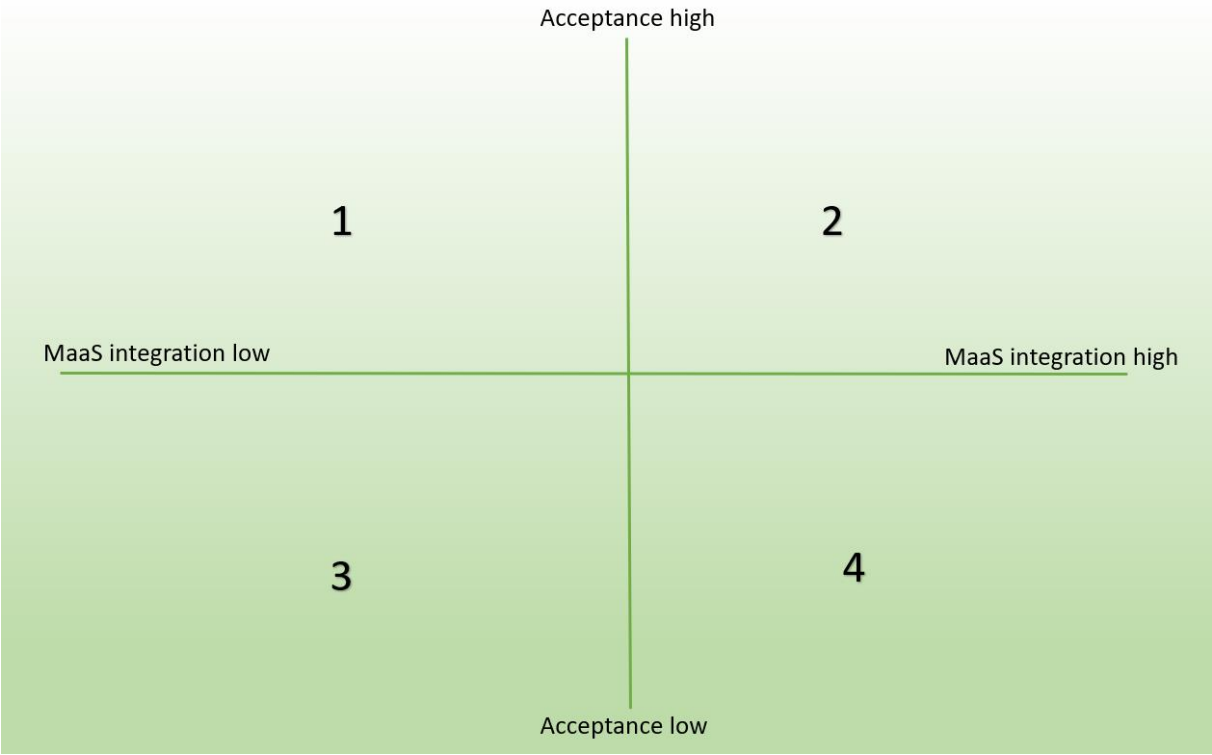
In this chapter, four scenarios will be constructed with regards to MaaS in Groningen. Firstly, the two drivers that will make up the scenario axes scheme will be chosen. Secondly, the scenario axes scheme will be drawn up using these two drivers. Then, the four quadrants representing the four scenarios will be discussed separately. Storylines for each four of them will be created. Lastly, from these four storylines four SWOT-analyses will be drawn up.

5.1 Scenario drivers

The axes for the scenarios have been based on the frequency of being discussed in the interviews, as well as how much they determine the success of MaaS. According to Meindert (2014) the objective in choosing the drivers is to find those that are also overarching or encompassing concepts under which the other uncertainties can be bundled and discussed. This has also been taken into account while choosing the drivers. Since the choice for the drivers is a subjective one and it is impossible to know for sure which drivers will eventually turn out to be the 'most' important, opinions with regards to their importance can differ. In this research the aim is to explore possibilities, therefore the drivers have been based upon exploring overarching themes and uncertainties to take as many factors as possible into account in the exploration.

1) **Degree of MaaS integration:** This driver has been chosen because it important for its connection to a lot of other factors, on which the success of MaaS will depend. Integration relates to the seamlessness of the service; the more integration the more travel options will be available and the more they can be attuned to each other. Therefore this also increases convenience for users, which in turn is an important reason to use MaaS services. More integration is also connected to more efficiency, which can also lead to more cost efficiency. Eventually for Groningen, the objective was to have more space (less cars) in the city and to contribute to sustainability. The amount of integration influences this to a large extent since more integration would mean a larger pool to choose travel options from and also shared mobility options which would contribute to both these objectives. However, low integration can be characterized as fragmentation of services. This would make them less attractive and probably also less cost efficient.
2) **Degree of acceptance**: This driver has been chosen because from the results section it appeared that degree of acceptance was very uncertain, multiple respondents mentioned having doubts with regards to the willingness to accept new modes of travel, and about how long it would take for people to do so [RES1, RES2, RES7]. From the theory it also became clear that changing travel behavior appears to be difficult. Furthermore, the degree of acceptance is also dependent other social factors such as convenience (which makes MaaS more attractive) and visibility (which makes people familiar with MaaS, which is necessary for them to want to use the services). Eventually, the degree of acceptance determines whether or not MaaS will be more widely adapted and generate revenue, which eventually decides if MaaS will even be able to exist.

The following scenario scheme in figure 5.1 has been drawn up using these drivers:



5.2 Scenario storylines

The following subheadings account for the four scenarios numbered 1-4 in figure 5.1. Each of them will now be discussed with a storyline that follows from the positioning of the scenario with regards to the drivers in the scheme. After the storylines a SWOT-analysis will be drawn up for each scenario.

1. **Fragmented MaaS** – Acceptance high, integration low

The first scenario is characterized by high acceptance of MaaS, but a low degree of integration. This could mean that in general MaaS services are offered, there is a substantial group of users, which could point to MaaS also generating enough revenue to be able to continue to develop. However, the low degree of integration indicates the services themselves are fragmented. Reasons for this have been mentioned by the respondents as difficulties with integrating various data-systems [RES 2, RES4] or difficulty integrating various transport providers due to competition [RES6]. In Groningen over a time horizon of about 10 years this could mean failure to integrate public transport and other travel modes with each other. The amount of integration is also dependent on various functions such as online booking, payments and other service offers that can be accessed through the MaaS service. Low integration can be a sign of fragmentation. This does not necessarily have to be a bad thing, but it can mean fragmented MaaS providers all operating on their own. Therefore efficiency can be hampered and also less easy to regulate or tune down to sustainability objectives. In Groningen, one of the most important objectives for the city

Figure 5.1: The scenario axes scheme for MaaS in Groningen with the drivers integration and acceptance.

was decreasing the amount of vehicles in the city [RES2]. If MaaS is fragmented this objective may be less easy to reach. The high acceptance of MaaS does open up opportunities to regulate towards more

sustainable travel modes since there it can be assumed there is common ground to build upon due to this high acceptance. This common ground can also be used when tuning regulation down towards objectives that the government has with regards to mobility.

Table 5.1: SWOT-analysis scenario 1

Strengths	Weaknesses
• General acceptance of MaaS • Substantial amount of MaaS users • MaaS generates revenue	• Fragmented MaaS • Less efficiency
Opportunities	**Threats**
• MaaS continues to grow • Common ground among users as a starting point for	• Fragmented services are more difficult to regulate • More difficulty achieving sustainability goals

2. MaaS Valhalla – Acceptance high, integration high

In the second scenario the degree of acceptance is high and the degree of integration as well. For MaaS in general this would be considered a positive outcome, since high acceptance indicates a substantial amount of users, and high integration indicates general and cost efficiency. This could mean a few MaaS providers will be available offering all types of travel modes through one platform, being the ideal situation (RES4, RES6]. High acceptance and integration would also mean a high convenience for users because integration means many options to choose from. This can mean an integration of public transport, bicycle sharing services, taxi services et cetera. In this scenario it seems that MaaS benefits the most from both a high level of integration and a high level of acceptance. However, if MaaS thrives and becomes increasingly popular it may be used intensively, which can also have a negative environmental impact. It is necessary to take regulatory precautions to avoid negative consequences of intensive use of MaaS. Also, rapid adoption of MaaS services by a large amount of users can be disruptive to the economy. Well integrated MaaS offers the option of adding autonomous driving and other smart mobility developments into the system.

Table 5.2: SWOT-analysis scenario 2

Strengths	Weaknesses
• Wide acceptance • Integration • Continued MaaS development • Easier to regulate	• Possibly increased mobility usage
Opportunities	**Threats**
• Increased mobility efficiency • Lower travel costs • Opportunities to add other smart mobility developments to MaaS	• Disruptive to the economy • Widespread MaaS could threaten sustainability

3. MaaS demise – Integration low, acceptance low

In this scenario both integration and acceptance are low. The acceptance is necessary for MaaS to grow and integration for making MaaS more efficient, which is one of its objectives, and keep the costs low. Therefore, this scenario appears to be the least successful with regards to MaaS. Generally, if the integration and the acceptance are still low within the coming 10 years, it is questionable if MaaS will pose real opportunities with regards to a more efficient and sustainable transport system in Groningen, as well as taking of the pressure of the transport system. In this scenario the positive point can be that if integration and acceptance are low and MaaS is desirable, there is time to develop strategies targeted at promoting MaaS and working towards more integration. Resources that can be deployed to do so, and have been mentioned in the interviews is the creation of more visibility for MaaS, carrying out more pilots to create a common base for different parties which will make integration easier and will also make people more acquainted with MaaS.

Table 5.3: SWOT-analysis scenario 3

Strengths	Weaknesses
• Stability (no new developments)	• Fragmented MaaS • Few users
Opportunities	**Threats**
• Time for making regulatory framework • Carry out more pilots • Create more visibility	• Mobility objectives of efficiency and sustainability are not met • High MaaS costs • MaaS failure

4. Small-scale MaaS – Integration high, acceptance low

In this last scenario the integration is high, but acceptance of MaaS services are low. That means the system works and is efficient and integrated, but the usage of the services stays behind due to low acceptance. This could be due to peoples unwillingness to change, or due to the fact that MaaS is integrated but still expensive or only targeted or accessible for a small group of users. That would also mean that MaaS possibly excludes other groups and does not benefit the majority of society. High integration means that there must be a substantial amount of cooperation between different parties to ensure this integration. That could be a base for further MaaS development, if desired, to achieve a more substantial amount of users.

Table 5.4: SWOT-analysis scenario 4

Strengths	Weaknesses
• Acceptance high • Efficiency high due to integration	• Low amount of users • Possibly only a specific group of users
Opportunities	**Threats**
• Cooperation • Common ground for further development	• MaaS does not contribute to sustainability • MaaS does not contribute to whole society – or sets certain groups behind

6 Discussion

In this chapter the results from the previous chapters 4 and 5 will be discussed and compared to the theory that has been discussed in chapter 2. First of all, the results from the scenarios and the SWOT-analyses will be discussed and compared om section 6.1. Subsequently, in section 6.2 some policy recommendations will be made on the bases of the scenario results and the comparison of the SWOT-analyses. Finally, the contribution of the research to planning practice will be elaborated upon.

6.1 Scenario Results

Following from the Scenarios and the SWOT-analyses in the previous chapter, the following points can be discussed with regards to the scenarios. The input from both theory and the interview results have been used to fuel this discussion. In the scenario scheme acceptance and integration have been the main drivers that have been used to build the four scenarios around.

The projects in Groningen mainly included projects concerning the integration of public transport and bicycle-sharing projects. From the four scenarios it became clear that both integration and acceptance would be determining whether or not MaaS will be a success. Even though in Groningen the projects are in their early stages, the outcomes of these scenarios can be helpful in thinking about what may happen if projects continue to grow and become full-fledged MaaS services. The interviews have proved to be very important in adding to the insights of the scenarios, since high or low acceptance in itself are just states of being and the strategies needed to change this mainly followed from the interview data.

For example what has been mentioned in the interviews is that visibility contributes to more acceptance and a more successful adaptation of such new travel modes. Visibility has not been mentioned in chapter two, the theory chapter of this research. However, with regards to MaaS it appeared from the interviews to be an important factor to take into consideration. Furthermore, the forming of new partnerships, such as the hive.mobility in Groningen can also make new developments, such as MaaS, more visible and attractive. The research points to this positive relationship, but it cannot yet be confirmed since the hive.mobility has just been founded very recently. However, this could potentially aid both acceptance and integration

From the interviews costs have been also mentioned by many actors to be determining the success of MaaS services. In section 2.2 the importance of MaaS costs in its development have been briefly touched upon. From the scenarios the costs only follow indirectly as a factor connected to both acceptance and integration. What becomes clear is that costs are an important factor for success in the long-term for MaaS development.

With regards to integration, from the interviews it followed that current integration levels in Groningen are not yet high. The most integrated MaaS resembling service is the NS public transport, which offers bike rental, taxi services, buses and trains through one platform and subscription. This can be considered integration level 2 (integration of booking and payment). Or, since NS also offers day trips including tickets for a day out and some food or drinks it can to some extent be considered integration level 3 (integration of the service offer, contracts). Since in Groningen public transport is such a large supplier of

transport services, the focus of any approach with regards to MaaS should take into account this public transport sector.

In Groningen, from the interview results, not much has been mentioned about the current amount of acceptance towards MaaS related developments. This makes sense since there has not yet been much research towards the acceptance of such travel modes. However this may be interesting to look into in specific contexts, to gain insight in the possibilities for MaaS from the users' perspective.

Finally, what has not been directly mentioned in the results, since it falls outside of the scope of this case study, is the importance of the connection in this particular case between the city of Groningen and the rural area surrounding it. This was mentioned as both important to consider when looking for opportunities for MaaS, as well as in considering the interconnectedness between the city and its surroundings with regards to for example work-related trips that occur every day.

'One prominent driving force is that it is difficult to provide access to rural areas [surrounding Groningen] and to keep them accessible and liveable.' [RES3]

RES3 pointed out that it is even an important driving force for developing MaaS, together with for example autonomous vehicles. In this chosen case study the focus has been on the city of Groningen, but it should be noted that traffic flows also go from other areas towards the city and are inextricably linked with the inner city. Therefore, when dealing with this type of development a more holistic approach of the city and its surrounding areas could be more suitable when conducting this type of research in the future. The added value of taking into account multiple scale levels in scenario research is also confirmed by Zurek & Henrichs (2007). However, it would have been too elaborate to fit the scope of this research.

6.2 Policy recommendations

In this section some recommendations for policymaking will be made. From the city plans for the coming years in Groningen there was an indication that they thought MaaS could be a possible solutions to some of their problems. However, they also indicated a need for further research into MaaS. In chapter 3 it has already been mentioned that in Groningen they recently started piloting with MaaS developments on a smaller scale with three projects: the Hubs, a bikeshare project and a carshare project.

In this research a few of these projects have been consulted as well as a few other respondents that have knowledge of MaaS developments. With the knowledge acquired, one of the aims of this research was also to make some recommendations for policy in Groningen. The interview data, the scenarios and the SWOT-analyses following from them have been used as input for making some policy recommendations in this section.

The SWOT-analyses from the four scenarios give some diverse information about what future may unfold with regards to MaaS looking at the two factors of acceptance and integration. In general, it can be perceived that the scenario 2 is the best scenario for MaaS, with both acceptance and integration high, whereas scenario 3 is the least favorable with low integration and low acceptance.

What can be taken from the SWOT-analyses in general is that high integration logically leads to higher efficiency and a lowering of the costs. This could be starting point for creating higher acceptance if this is

not present yet. The other way around, a high acceptance can be the base for more integration, since there seems to be a market for MaaS and efficiency and cost benefits are not are not optimally utilized.

What stands out is that even with low integration and low acceptance (Scenario & SWOT 3) this may not be a problem, since the time horizon is 10 years and that could simply mean that the development is going slowly. Developments that are as disruptive as MaaS can use some extra time to be backed up by solid regulation and to make sure the effects on the economy are also limited, which would not be the case in scenario and SWOT 2.

Eventually, these scenarios and SWOT-analyses appear to be helpful in thinking about possible outcomes for MaaS development under certain circumstances in Groningen for the coming 10 years. However, since development is a dynamic and not a solid process the scenario results and storylines should also not be regarded as something solid. They can be used to broaden the view on what may happen in the future and from there it can be decided what will be helpful in such a state or situation.

Following from the literature, the interview results and the scenarios, the following recommendations can be distinguished:

1. Continue piloting to learn more about what works and what does not for MaaS in this specific context. Due to the newness and uncertainty about MaaS, especially in specific context a learning by doing approach is needed till the best practices become clear.
2. Make use of partnerships for efficient cooperation and integration. Sharing knowledge can increase carrying capacity and create a foundation for successful development.
3. Find new ways of regulation that fit contemporary development and that allow in a specific context to achieve the most desired objectives. An example of this could be that regulation for MaaS providers should focus on setting requirements about the offering a certain amount of sustainable travel modes, or shared transport options.
4. Focus on incentives and visibility to make people aware of the possibilities and promote MaaS.

A possible helpful approach while implementing MaaS can be dynamic adaptive policymaking (DAP). This style of policymaking is now used while implementing MaaS in the Dutch city of Nijmegen (Marchau et al., 2010; Jittrapirom et al., 2018). Other adaptive policy that are suitable for governing uncertain developments such as MaaS can also be: 1) Policymaking Pathways (Lyons & Davidson, 2016), 2) Adaptive Planning (Rauws, 2017), 3) Reflexive governance (Marsden & Reardon, 2018). These can be suitable approaches while planning for future MaaS development.

What all these approaches have in common is the notion that complex and uncertain development, such as MaaS, is in need of flexible governance approaches. By flexible meaning adjusting and re-adjusting to circumstances, and taking into account different roles and actors. The smart mobility developments, such as MaaS, are likely to be in need of governance carried out by different parties and different roles than the traditional ones. In MaaS there are economic as well as societal goals that need to be taken into account, and sufficient governance is needed to make this happen. These new developments ask for an approach that balances state-, market- and societal needs (Loorbach, 2010).

Another recommendation is about one of the new forms of governance that generally supports new developments such as MaaS that are characterized by changing governing roles. This form is called public-private cooperation (PPC). It is characterized by partnerships formed between public and private parties to achieve complementary goals (Schaeffer & Loveridge, 2002). However, the form and success of the cooperation depends on three factors (ibid.): 1) Compatibility of goals, 2) Coordination of decisions, 3) Commitment of resources.

The new partnerships and forms of cooperation resulting from and necessary for MaaS have to take these three points into consideration. It is evident that the more the goals, coordination and commitment are alike between parties involved, the more successful such new forms of cooperation will be. For MaaS development, PPC can pose opportunities for integration and having an approach do deal with new and uncertain developments.

6.3 Contribution to planning practice

Generally, from chapter two it followed that the scenarios would aid strategic decision making in developments (such as MaaS) characterized by 'deep' uncertainty. In the case of this research, the scenarios helped to envision how development may unfold and what problems may arise. However, while these scenarios do help the thinking process about important factors that need to be considered and directions that developments could go in, it appears that not much more can be taken from them. This is because the decision for the drivers, as well as the construction of the storylines are a subjective process. They would have had more credibility if done with a group of people, but it would still not be able to know if they approach what is most importance.

What also makes it difficult to value the contribution of this research is that developments were in really early stages. More research is needed to assess and reassess the situation in the specific context as it gradually develops. The practical ways to for example increase acceptance or lower costs can only be determined after more thorough practical research in a specific situation. Knowing what works and what does not would help filling in scenario storylines. Therefore, this research serves a starting point to making plans taking into account the opportunities and threats that may arise in MaaS development. However, how the development may unfold exactly will still be a process of trial-and-error.

If combined with an adaptive policymaking approach and clear objectives, this research can aid with making strategic decision for the future of MaaS in Groningen. Furthermore, it can serve as an example for other cities that are also starting to develop policies and plans for implementing MaaS-related mobility services. The interviews with experts have led to an extensive amount of valuable information about possible MaaS development, opportunities and barriers that can prove to be useful for other contexts alike. The scenario approach has proven to be a valid method to start the thinking process about MaaS.

Also, in a time in which a lot of other changes are also taking place, such as the energy transition and climate change, there is a need for governing these very uncertain developments. MaaS can serve as an example that falls in the same category, and is in need of new ways of governance that benefit these type of developments.

7 Conclusion(s)

First of all, this research has been focused on a newly emerging development in the mobility domain, specifically Mobility as a Service. This new development, as has been discussed before, could as became clear from theory be a solution to some mobility problems like congestion, scarcity of public space and (air)pollution. However, from theory it became clear the uncertainty in the unfolding of the development and the possible negative effect, such as an increase in mobility consumption putting possibly a larger strain on the environment or negative social consequences like exclusion or mobility poverty.

Since the development turned out to be in its infancy and entailed changes in the mobility system on various levels and fields, anticipating on its future development turned out to be complex bringing with it a substantial amount of uncertainty. However, to even in such a situation be able to think critically about the possibilities and threats for future MaaS development, possible scenarios have been composed following from literature and interviews with experts. These scenarios in turn can be used to help with policymaking, regulation an decision making governance for the future of MaaS.

The sub questions that have been put together in this research will be shortly answered here now, followed by an answer to the main research question. The first sub question was:

How to define Mobility-as-a-Service from a theoretical perspective?

The concept has been analysed through studying relevant literature, and from that a few leading elements were found to be part of MaaS. In MaaS there occurs a shift from ownership to usership of vehicles. Furthermore it uses technology to integrate travel modes and offer services through a platform. Next to that, MaaS offers the possibility of customizing your travel preferences. Also, as followed from the literature, MaaS is characterized by four levels of integration, which also determine to a certain extent how far developed MaaS is in a certain place and time. The adoption of MaaS by users in practice is dependent on peoples willingness to change travel behavior and accept MaaS as a new transport option.

The second sub question was:

What are the roles of uncertainty and governance with regards to future MaaS development?

From the literature it became clear that MaaS is a complex development, which is why it brings about a lot of uncertainties. These uncertainties mainly had to do with the unknown direction which the development would go in, and the lack of other previous developments that could pose an example of how to deal with this type of new development.

From the interviews it became clear that respondents also saw opportunities for MaaS, but also acknowledged the presence of this uncertainty. The uncertainties mentioned ranged from whether MaaS would even be accepted as a new travel mode, to whether it would be possible to integrate the services of various mobility providers to facilitate MaaS. Other uncertainties were about privacy and security of MaaS, which parties would be involved in MaaS and how MaaS would contribute in the long run to various objectives such as sustainability and mobility efficiency.

What followed from the uncertainties was that there was a need for tools to get insight in how to deal with MaaS development now to ensure that it would contribute to mobility development in a way that would benefit society. This resulted in the need for governance to deal with the perceived uncertainties. Governance is about steering, facilitating or enabling developments to make sure they go in a direction that is preferred. From the interviews it became clear that this was difficult to determine how to do this for MaaS, since it was not even always clear which roles should be taken by which parties, and what the preferred direction was.

The third sub question was:

What are the drivers and uncertainties of MaaS development for the future in Groningen and what possible scenarios follow from them?

From the literature it became clear that to construct scenarios drivers and uncertainties about the chosen development, MaaS in this case, needed to be determined. Resulting from the interviews MaaS drivers with high uncertainty mostly mentioned and discussed by the respondents were MaaS acceptance and MaaS integration. These two drivers turned out to be crucial in MaaS general development, as well as being overarching themes under which other factors discussed in the interviews could be accommodated.

Eventually these two drivers have been plotted on a scenario axis scheme, from which the four scenarios followed. A SWOT-analysis had been performed afterwards to support the scenario storylines and serve as a starting point for the policy recommendations. This eventually makes it possible to also answer the main research question:

What are possible scenarios that Mobility-as-a-Service can generate in Groningen for 2030, and what policy recommendations can be made about them?

The four scenarios generated by the drivers MaaS acceptance and MaaS integration all have diverse storylines that have been supported by the input from the interview data. What the scenarios show is that however MaaS development may unfold, there are always opportunities that can be aimed for to make the best out of it. Every storylines turned out to have its strengths and weaknesses. High acceptance and high integration could also turn out to be problematic for example for the environment. And low integration and low acceptance could mean that strategies need to change and there is time for making a regulatory framework. An important conclusion is then that the storylines are not leading or solid in that if something happens they provide the solution. They do give some insight in what may happen which can help with policymaking.

As far as policy recommendations go there is a need for specific forms of governance to enable and steer MaaS development. This follows from the fact that it is a new and complex development, and due to its dynamic nature approaches need to be adapted to lessons that still have to be learnt while time passes. The complexity of MaaS development also stems from the fact that many factors are involved in it, which can also be seen in the results chapter 4. From the scenario storylines also follows that many these factors interplay. They all have to been taken carefully into consideration, since the outcome of the interplay of these factors is still unknown.

An holistic and adaptive approach for MaaS is therefore strongly advised. The scenarios that have been constructed serve as a tool to get more insight in possible development of MaaS concerning certain factors. They can be a helpful too envisioning the opportunities but also the threats that MaaS development may pose in a certain context for the future. The greatest challenge for this will be to govern MaaS development so that societal, environmental and economic purposes are served. To be able to do this there is a need for different parties involved to work together effectively into create a basis for the development. Furthermore, policies dealing with MaaS need to be adaptive to the vast and uncertain changes that this type of development brings about. This is because Maas development can be expected to bring about substantial change in the way the mobility system works. A way to do this is to make use of adaptive policymaking approaches. These approaches take into account multiple possible development paths and give room for adapting policy plans if circumstances change. If governing bodies are able to do this MaaS will be able to come to its full potential and contribute to a more efficient and environmentally sustainable transport system.

8 Reflection

For the reflection there are several points that can contribute to better results while conducting research alike in the future. For the scenario research conducted, it would have been better to have more rounds of interviews with the same respondents to talk about established drivers and uncertainties. That way the research could be more credible, since the answers to questions could be tested multiple times and against those of other respondents. Furthermore sessions with multiple respondents together would have brought more of a discussion. However, due to time constraints this was not possible.

Due to the newness of the subject, it turned out that not many people were very familiar with the subject of research. It can therefore be argued that in this start-up phase the group of respondents to interview about the subject can be considered complete/exhaustive. However, the suggestion for further research is that since several MaaS projects are only now starting up around this time, that within the coming few years more respondents can be found and also more information could be gathered as to what direction the development is taking and what factors stand out.

From the interviews a few respondents [RES2, RES3, RES4, RES6] mentioned that MaaS developments may actually pose substantial opportunities for the connection between the city of Groningen and the rural areas surrounding it. In further research it can interesting to take a closer look at this. Furthermore, this research has been a case study in a single city of a transport related development. However, cities are always connected to other cities through transport, so that also deserves more attention in future research.

The theory chapter has been enriched with more information from the data gathered in practice. Specifically, after the data gathering it stood out that people's behavior, perceptions and willingness to change (habits) was extremely important within the research about future development and adoption of MaaS-related travel modes. So this extra information has been added later on to section 2.2 in the thesis to make it more exhaustive.

From the coding process of the interviews the decision has been made to do an analysis based on the general occurring themes that have been determined by the frequency of occurrence of different codes. However, it can be argued that for scenario research it would also be valuable to look at codes that were occurred less frequently since they can be considered outliers.

The group of experts consulted for this research exists of some respondents from the government, a scholar and respondents from pilot projects. This group of respondents could benefit from an enrichment from a MaaS operator expert, which is a more market focused perspective. However, in Groningen no MaaS operators are active at this time. In due time it would be a valuable addition to interview one of them as well.

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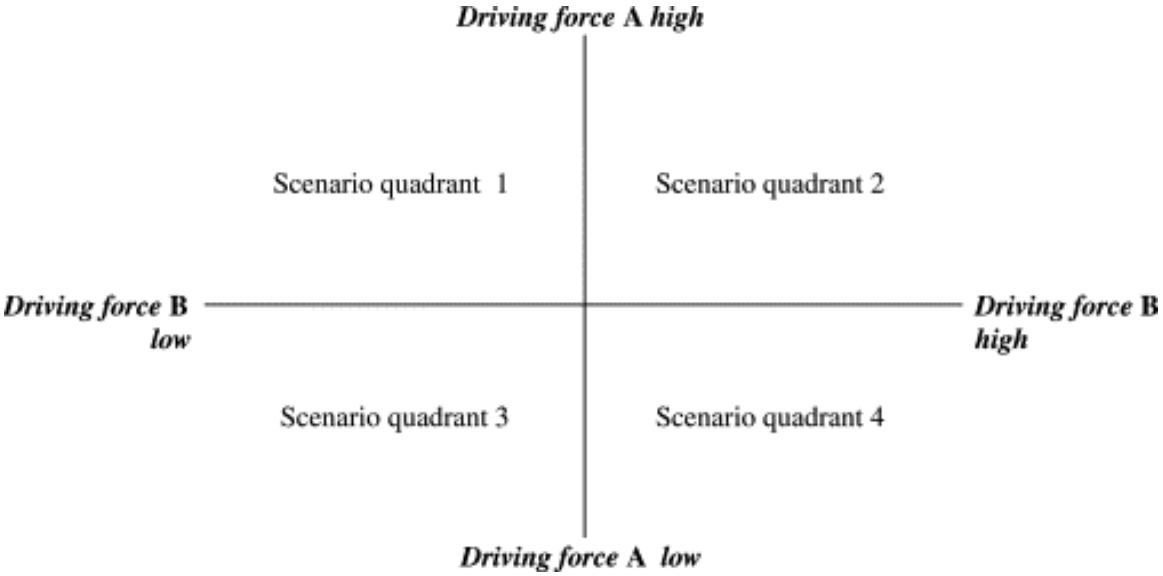
Appendix 1.A – Interview questions

Interview Guide Semi-Structured interviews (in Dutch)	
Onderwerp:	***Vragen:***
Introductie	• Wie ben ik? • Wie bent u? Wat zijn uw achtergrond en werkfunctie? • Wat houden mijn onderzoek en het onderwerp van dit interview in?
MaaS (Groningen) algemeen	• Heb je kennis van MaaS? • Wat zie je van MaaS in je dagelijkse werkomgeving of projecten? • Zie je barrieres voor MaaS? • Wat denk je dat de invloed van MaaS in Groningen op het mobiliteitssysteem zou kunnen zijn?
MaaS Scenario-assen	• Welke factoren zijn volgens u de grootste drijfveren voor MaaS? **DRIVERS** • Welke van deze factoren zijn het meest onzeker of hebben de grootste impact? **DRIVERS & UNCERTAINTIES**
Toekomst (Groningen)	• Wat zegt het vorige over de toekomst van MaaS in 2030 – ten aanzien van de meest onzekere en impactvolle drivers. (hoever zal de ontwikkeling mogelijk wel gaan/niet gaan) • Waardoor komt dit? **GOVERNANCE** • Wat is wenselijk en wat is mogelijk? **GOVERNANCE** • Discussie.
Afsluiting	• Samenvattend, nog laatste vragen? • Nog andere nuttige contactpersonen? • Bedankt!



The figure has been used to demonstrate the idea of the scenario axes to the respondents.

Appendix 1.B – Interview transcripts

Due to confidentiality interview transcripts can be requested from the author.