Mobility as a Service

Identifying possible socio-technical scenarios in the network of expectations

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Preface

This document is the result of the master's thesis about socio technical scenarios flowing from expectations of the involved actors on Mobility as a Service. The research is conducted as the final part of the master Sustainable Business and Innovation at Utrecht University. Within the research, expectations on Mobility as a Service were used as input for developing possible socio-technical scenarios. As such, the topics covered are socio-technical transitions, socio-technical scenarios, and the role of expectations.

Acknowledgements

I wish to express my sincere appreciation to my supervisor dr. Jacco Farla from Utrecht University for his guidance and feedback throughout my thesis. He encouraged me to do the right things and kept me on track. I would also like to thank Mark Verbeet from the city of Utrecht and other colleagues I have been in contact with for guiding me throughout the municipality. Without all my interviewees I would not have been able to finish this thesis, so thank you all for your time and effort.

Abstract

This study explores the possible socio-technical scenarios regarding Mobility as a Service, by using expectations of the involved actors as starting point. Mobility as a Service is a relatively new concept, attracting the attention of researchers, businesses, and public authorities. On paper, Mobility as a Service has the potential to contribute to solutions regarding climate change and urbanization, but practice has not yet shown this. To eventually get to this promising future, developments influencing Mobility as a Service should be aligned. The strategies of the involved actors are influenced by their expectations on a certain development. With a de-alignment of expectations, delay on the development could be caused. As the expectations on Mobility as a Service have not yet been researched, these are used as starting point for this research. To compare the expectations, these are narrated into socio-technical scenarios. This research addresses the question: *What are the expectations of the actors involved in implementing Mobility as a Service in urban areas in the Netherlands, and what socio-technical scenarios can be derived from these expectations?* A qualitative research is performed, collecting and analysing expectations from involved actors. The identification of divergences throughout these expectations were used to construct the socio-technical scenarios. From there, three scenarios evolved differing in the degree of transformation of the mobility system and the influence of public and private parties. In two of these scenarios, Mobility as a Service becomes an add-on to the mobility system, without large scale changes in the future of urban mobility. The other scenario showed a substantial change of the future urban mobility system by Mobility as a Service, enhancing a socio-technical transition. The adoption of the roles by the involved actors influenced the transition pathways of the different scenarios. So, depending on which of the outcomes is preferable, actors can adopt a certain role and influence the direction of the development regarding Mobility as a Service. Nevertheless, the expectations diverge on the potential of Mobility as a Service, transforming the urban mobility system.

Keywords: Mobility as a Service, expectations, socio-technical scenarios, urban mobility, socio-technical transition

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1 Introduction

With a continuous growing world population, specifically in urban areas (UN, 2018), it becomes a challenge to sustainably absorb this growth and keep cities liveable (Cohen, 2006; Nabielek, Kronberger-Nabielek & Hamers, 2013; PWC, 2019). One of these challenges is managing their mobility system (Jittrapirom, Marchau, Van Der Heijden & Meurs, 2018). Due to spatial division of labour and living, mobility movements increased, as well as the environmental impacts coming with it (Wegener, 2013; Kamargianni & Matyas, 2017). Therefore, cities suffer from a range of negative externalities, such as congestion, extended travel times and poor air quality (Banister, 2011; Cohen, 2006; I&W, 2017a), but also the space taken by vehicles within cities (PBL, 2009).

An emerging business model from recent technological developments, such as digitalization, having the potential of contributing to solving (part of) these mobility issues, is Mobility as a Service (MaaS) (Holmberg, Collado, Sarasini & Williander 2016; CIVITAS, 2016; Kamargianni & Matyas, 2017, Li & Voege, 2017). MaaS could possibly become a socio-technical transition, combining several technologies to offer a multimodal routing and insists on behavioural change. MaaS can potentially contribute to achieving the CO_2 emission reduction targets, reduce congestion issues, use urban space more efficiently and reduce the crowded public transport (Goedopweg, 2019; I&W, 2019a; PBL, 2009). The aim of MaaS is to bring the public and private transport operators within a city closer together (Kamargianni & Matyas, 2017) and give rise to a shift in the provision of urban mobility (Li & Voege, 2017). MaaS offers flexible, efficient, user-focused, and personal services (Ho, Mulley & Hensher, 2019), by convenient and comfortable travel options without owning a car (Li & Voege, 2017).

Also, within the Netherlands, urbanization is a trend (Statista, 2017; PWC, 2019). The resulting issues, such as high population density and congestion are on the political agenda (RIVM, 2019). Investments in infrastructure or subsidies in public transport are not able to solve these issues, but MaaS is seen as a potential solution for (some of) these issues (I&W, 2019a). According to the Rijksoverheid, MaaS can improve the mobility system and is seen as the next step towards data and information driven infrastructure (I&W, 2019c; I&W, 2019d). This results in more efficient travels for the traveller and the cities (I&W, 2019c). Whereas for example the MaaS Alliance in Belgium and Ubigo in Sweden are leaders concerning MaaS, the national government steers the development of MaaS in the Netherlands (I&W, 2019c). With seven pilots in different regions, the Ministry of Infrastructure and Water Management, and other involved municipalities and parties, try to learn together how to optimize the mobility system within the Netherlands.

As MaaS is a relatively new concept, limited research has been done about the basis of MaaS development (Ho, Mulley & Hensher, 2019). Current studies on MaaS focus specifically on the operational business models (Kamargianni & Matyas, 2017), institutional and infrastructure requirements (Sochor, Strömberg & Karlsson, 2015; Mukhtar-Landgren, Karlsson, Koglin, Kronsell, Lund, Sarasini, Sochet & Wendle, 2016; Deloitte, 2017; Li & Voege, 2017), the potential impacts on public transport contracts and operations (Hensher, 2017; Smith, Sochor & Karlsson, 2018), user preferences and willingness to pay (Caiati, Rasouli & Timmermans, 2018; Ho,

Hensher, Mulley & Wong 2018; Matyas & Kamargianni, 2019; ITS Australia, 2018; Hartikainen, Pitkänen, Riihelä, Räsänen, Sacs, Sirkiä & Uteng, 2019; Ho, Mulley & Hensher, 2019; Kamargianni, Matyas, Li & Muscat, 2018). There are also a few critical reviews on MaaS literature as there is a lack of understanding MaaS on a conceptual level (Giesecke, Surakka & Hakonen, 2016; Jittrapirom, Caiati, Feneri, Ebrahimigharehbaghi, Alonso-González & Maryan, 2017), lack of an assessment framework (Jittrapirom et al., 2017), uncertainty about technological feasibility, future demand and willingness of crucial stakeholders to cooperate (Jittrapirom et al., 2018), the current state of MaaS research and where to focus on in the future, like the monitoring of mobility data (Utriainen & Pöllänen, 2018; Lyons, Hammond & Mackay, 2019). MaaS is a user-centric approach, but a network of collaborating actors is needed to make MaaS a success (Kamargianni & Matyas, 2017). Remmerswaal (2018) already identified stakeholder preferences for MaaS in the case of Nijmegen but does not incorporate the future dynamics. The main stakeholder preference coming from Remmerswaals' study is the removal of institutional barriers. Smith, Sochor & Karlsson (2018), already made three scenarios for the future development of MaaS, mainly looking at the changing roles and implications for public transport operators.

To add to the current literature, expectations on MaaS held by involved actors will be researched. By taking expectations as starting point, insight will be gained on possible future pathways according to different actors. As expectations guide activities, and strategies of involved actors regarding innovation, only innovations with coherent, mutual, and aligned strategies succeed (Truffer, Voß & Konrad, 2008). Through translating the expectations into socio-technical scenarios, the expectations become coherent narratives and can be compared to each other. The research question resulting from this is:

What are the expectations of the actors involved in implementing Mobility as a Service in urban areas in the Netherlands, and what socio-technical scenarios can be derived from these expectations?

To answer the question, a case study is conducted using three MaaS pilots within the Netherlands: i) Amsterdam Zuidas, ii) Utrecht Leidsche Rijn, Vleuten and De Meern, and iii) Rotterdam The Hague (including Airport). Within the case study, the focus lied on MaaS within the urban areas of the Netherlands.

As this research takes expectations as a starting point for the identification of possible development pathways, it adds to the existing research about MaaS. By doing this, differences in expectations between the involved actors have been identified, which has not yet been done in existing literature. Adding on this, roles have been allocated for the involved actors. The scenarios explore a wide range of actors' expectations and this allows policy and decision makers to explore them (Elzen, Geels & Hofman, 2002).

The scenarios evolved from this research can serve as guidance for debates on policymaking. From there can be identified which technologies should be further developed and are in need for more support and investments. Besides, the expectations can serve as input for the social and political prioritization for the development of new technologies (Eames & McDowall,

2010). As the potential impact of MaaS is promising for society, they have an interest in the success of MaaS. By identification of differences in expectations, it becomes possible to work on the alignment of these expectations to eventually come to coherent, mutually supported, and aligned strategies (Truffer, Voß & Konrad, 2008).

2 Theoretical background

2.1 Mobility as a Service

Within the existing literature there is a variety of definitions of MaaS (Jittrapirom et al., 2018). It is seen as a concept, a socio-technical phenomenon (Giesecke, Surakka & Hakonen, 2016), or as a new mobility solution (Jittrapirom et al., 2018). For this study MaaS is defined as *a multimodal mobility service with existing and new ways of mobility, where the customer can customize its travel opportunities for door-to-door transport planning, with a single digital platform, including personalized payment options* (MuConsult, 2017; I&W, 2018; Deloitte, 2019; I&W, 2019a). Adding to this definition, Jittrapirom et al. (2018) defined nine core characteristics of the MaaS concept based on literature review (see Appendix I). These characteristics are, MaaS:

- integrates transport modes;
- offers customers different tariff options;
- relies on a single digital platform such as a mobile app;
- is built on the interactions between different groups of actors;
- makes use of different technologies;
- has a demand orientation;
- requires users to register through an account subscription;
- gives room for personalization to give tailor-made solutions;
- gives room for users to customize the offered service according to their preference.

One characteristic is not specifically mentioned in the definition, which is the interaction between different groups of actors. Although this is an important aspect and can be derived from the definition, as different actors deliver the different aspects of MaaS, such as the platform, the payment solutions etcetera.

2.1.1 Involved actors of Mobility as a Service

As the interaction and collaboration between actors is key to MaaS, these are visualized in figure 1. Within a business ecosystem, as called by Moore (1993), actors co-evolve their capabilities around an innovation. Kamargianni & Matyas (2017) visualized this for MaaS, building on the business ecosystem of Moore (1993), with all the involved actors. Every level has another level of commitment to the MaaS provider (Moore, 1993). The core consists of the MaaS provider and the directly involved actors, such as the suppliers and customers. From there, the extended layer consists of the supply chain, involving the complementors and second-layer suppliers. The outer layer, the so-called business ecosystem, might not be directly involved with the business operations, but have a significant influence on the success of MaaS through their power.

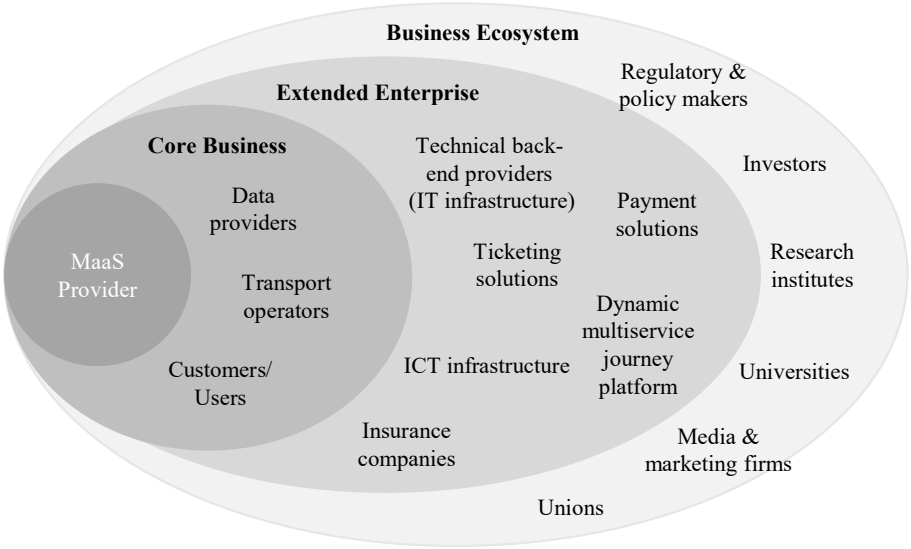

Figure 1 The MaaS ecosystem (Kamargianni & Matyas, 2017)

The MaaS provider is a central actor and is needed to enter the transport market and realize MaaS. Kamargianni & Matyas (2017) conclude this actor can be a private firm, as well as a public transport authority. According to Smith, Sochor & Karlsson (2018, p.593), the MaaS provider can be further divided into the MaaS integrator and the MaaS operator, whereas they define them as:

- The MaaS integrator "*mediates the offerings of the several transport service providers (and potentially other suppliers) to MaaS operators through activities such as technical integration, contract management and financial clearing*"
- The MaaS operator "*delivers MaaS to end-users by enabling them to seamlessly plan, pay for and execute use of public transport and other transport services, through a single interface*"

Based on this distinction, there are three possible scenarios where the role of the public sector differs (Smith, Sochor & Karlsson, 2018). The first scenario is the market-driven development, see figure 2a. The MaaS operator and MaaS integrator are absorbed by incumbent private actors or new MaaS focused start-ups. Within this scenario, the public control would be in the associated conditions, and they would act as an enabler rather than a driving force. The second scenario is the public-controlled development, see figure 2b. The public sector is responsible for the adoption of the MaaS integrator and operator roles. The public sector orchestrates and funds the development, implementation, and operation. In addition, they could procure the development and operations of the MaaS operator and integrator services from private actors and possibly create new MaaS organizations. And lastly, the third scenario, the public-private development, see figure 2c. The public sector takes the role of the MaaS integrator, whereas the MaaS operator will be adopted by a private actor. Like the market-driven development, the public sector enables the private sector. However, the MaaS integrator is taken by the public sector and acts as a 'neutral buffer', mitigating dominance of the MaaS operator.

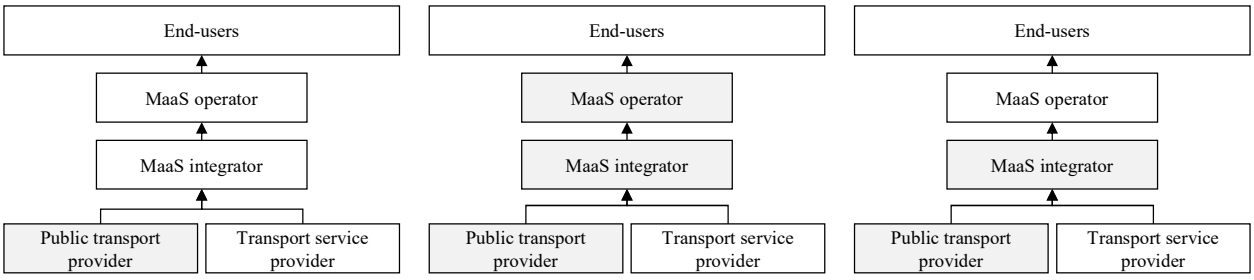

Figure 2a Market-driven development Figure 2b Public-controlled development Figure 2c Public-private development

Figure 2 Three scenarios on the future development of MaaS (Smith, Sochor & Karlsson, 2018)

2.2 Socio-technical transitions

As MaaS could possibly lead to a socio-technical transition, and expectations around it arise, first a socio-technical transition should be explained with the embedded levels and the interplay. A socio-technical system consists of a network of actors and institutions, as well as material artefacts and knowledge (Geels, 2004; Markard, 2011; Weber, 2003; Truffer, Voß & Konrad, 2008). These are interrelated and depend on each other (Finger, Groenewegen & Künneke 2005; Hughes, 1987), providing specific services for society (Markard, Raven & Truffer, 2012). When looking at a socio-technical transition, a set of processes fundamentally changes the system (Geels & Schot, 2010; Kemp, 1994). Such a transition involves changes along different dimensions (e.g. technological, organizational, economics) and a broad range of actors (Markard, Raven & Truffer, 2012).

A conceptual explanation of the interplay of dynamics within a socio-technical transition is the multi-level perspective (MLP) (Geels, 2005; Rip & Kemp, 1998; Hoogma, Kemp, Schot & Truffer, 2002). Transitions are viewed as non-linear processes resulting from alignments of developments at three levels, see figure 3 (Geels, 2002). The landscape level is a set of deep structural trends and the external structure or context for the interaction between actors (Geels, 2002). Within the landscape there is a set of heterogeneous factors, such as oil prices, economic growth, wars, emigration etc. The socio-technical regime level is a complex network of regimes, such as technology, infrastructure, culture, industrial network, knowledge, policies, and user practices (Geels, 2004). The regime is the rule-set embedded between the innovation and the landscape (Rip & Kemp, 1998). At the technological niche level, radical innovations are generated and developed (Geels, 2002). The relation between the niche and the regime determines the development of the innovation (Markard & Truffer, 2008).

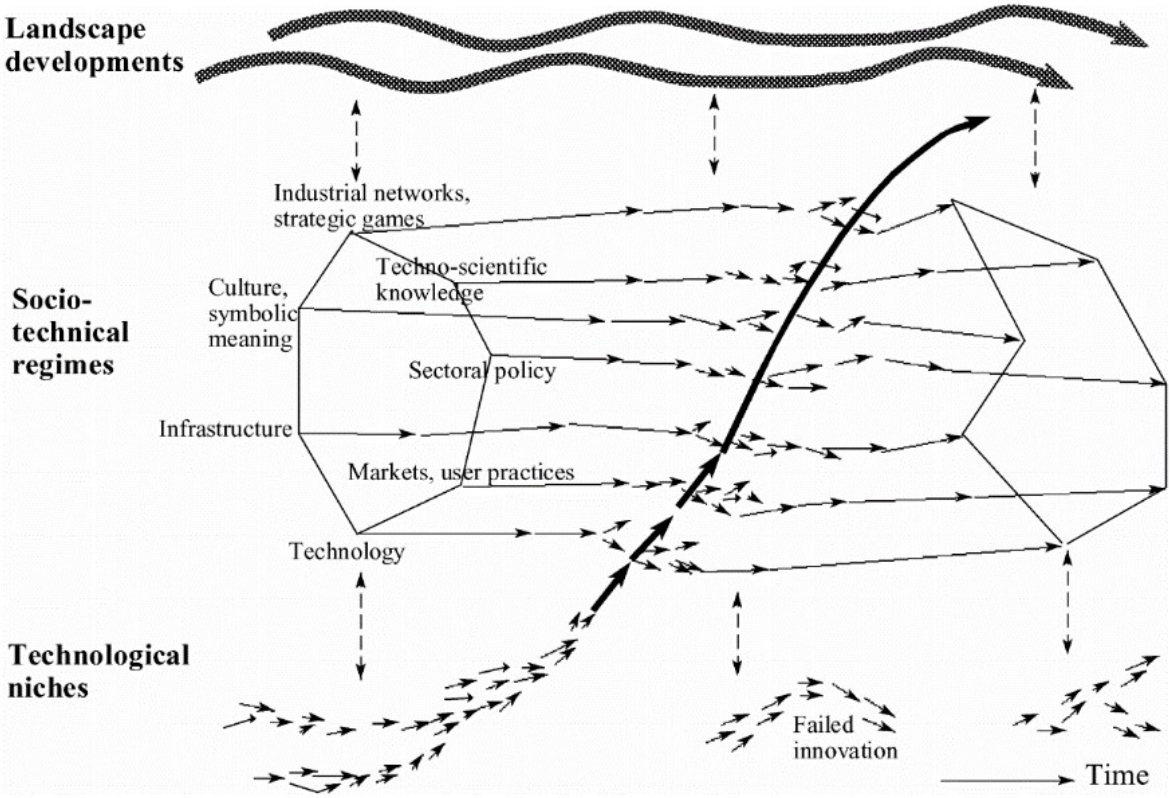

Figure 3 A dynamic multi-level perspective on socio-technical transitions adapted from Geels (2002)

2.2.1 Transition pathways

The dominant development in figure 3 is the bottom-up, niche driven development. The MLP is more refined and different multilevel interaction exist. Geels & Schot (2007) developed a typology of transition pathways. These pathways are based on two criteria, the timing of interactions and the nature of interaction. The timing of interactions is mainly about the timing of landscape developments pressuring regime and the state of niches innovations. The nature of interaction is based on the relationships of niche innovations and landscape developments with the regime. This can be a reinforcing relationship, which stabilizes the regime and do not drive a transition, or a disruptive relationship, putting pressure on the regime leading to change (Suarez & Oliva, 2005).

Based on these two criteria, four different transition pathways have been developed by Geels & Schot (2007). There is a possibility a transition starts on one pathway and shifts to another one during the transitions. As starting point of stability and reproduction there is the *reproduction process*. This means there is no external landscape pressure and the regime remains dynamically stable and reproduces itself. If there is no external landscape pressure, the regime will only undergo incremental change.

The first transition pathway is the *transformation path*. In this path there is moderate landscape pressure, but the niches are not significantly developed. Here the regime actors will adjust their development path and innovation activities. Existing regime actors take the lead, as the niche-innovations are not in place and cannot take advantage of the landscape pressure. Within

this transition pathway, external groupings, like societal movements, scientist, or entrepreneurs, have an important role. They communicate the landscape pressures and draw attention to negative externalities.

The second transition pathway is the *de-alignment and re-alignment path*. Within this pathway abrupt landscape changes appear and increase regime problems. Within the regime there is de-alignment, which opens new opportunities for niche innovations. If there is no niche innovation developed, there is no substitute for the regime. Multiple niche innovations co-exist, and rivalry exist between them. One niche innovation eventually becomes dominant and the core for the re-alignment of a new regime.

The third transition pathway is the *technological substitution path*. This transition starts with much landscape pressure at a moment in time where the niche innovations have been developed sufficiently. These niche innovations will eventually break through and replace the existing regime. As the regime is stable, niche innovations do not attract the attention of regime actors. With the landscape pressure on the regime, niche innovations can replace the regime, as the regime actors have not developed to be able to overcome the landscape pressure.

The fourth transition pathway is the *reconfiguration path*. On the niche level, radical innovation has developed into niche, and with a symbiotic relationship, can be easily adopted in the regime as add-on or replacement of a certain component. Same as in the transformation pathway, the new regime grows out of the old regime.

2.3 Sociology of expectations

Within a socio-technical transformation, the expectations held by different actor groups are important for the development of the transformation (Truffer, Voß & Konrad, 2008; Geels & Raven, 2006; Geels, 2002; Geels & Schot, 2007; Manders, Wieczorek & Verbong, 2018). When expectations are shared, they can be used as a resource to legitimize action and as heuristics to guide decisions (Van Lente & Bakker, 2010; Truffer, Voß & Konrad, 2008).

Within the sociology of expectations, different approaches exist, with the primary focus in social studies of science, technology, and society (Borup, Brown, Konrad & Van Lente, 2006). Due to the performative nature of expectations, they attract the interest of involved actors and define their roles by building mutual obligations and agendas (Borup et al., 2006; Truffer, Voß & Konrad, 2008).

It is not the competition between technologies, but expectations about the performance of a technology determining the success (Klepper, 1997; Rosenberg, 1976a; Rosenberg, 1976b; Van Lente & Bakker, 2010; Phillips, 2001). Alkemade & Suurs (2012) defined the role of expectations in determining the direction of technological change and the adoption rate of innovations. Expectations can be used as a coordination mechanism for actors and activities (Konrad, 2006). Through alignment and coordination of expectations, legitimacy can be created for a new technology (Brown & Michael, 2003; Truffer, Voß & Konrad, 2008). Expectations play a role in mobilizing resources and in creating protected niches for the new technology (Geels & Smit, 2000; Borup et al., 2006). By sharing these expectations uncertainty perceived by technology developers can be reduced and guide the process of technological change. Especially in the earliest phase of

the life cycle, the role of expectations is of major importance (Van Lente, 1993; Anderson & Tushman, 1990).

Expectations are circulating in different forms and shapes (Borup et al., 2006; Berkhout, 2006). Berkhout (2006) sees expectations as "bids" or future-oriented propositions which are interjections flowing from the present. Konrad (2006) described expectations as an emergent product of social interaction. According to Borup et al. (2006), in general expectations are "*the state of looking forward"*, but technological expectations can be specified to be *"real-time representations of future technological situations and capabilities"*. As this research is about a socio-technical transition, the latter definition from Borup et al. (2006) on technological expectations will be appropriate.

On the social expectation dynamics, a distinction can be made between individual expectations and collective expectations (Konrad, 2006; Truffer, Voß & Konrad, 2008). The individual expectations include the expectations from organizational actors, such as firms, NGOs etc., whereas collective expectations serve more as common point of orientation for several actors (Konrad, 2006; Truffer, Voß & Konrad, 2008). These collective expectations result from the exchange of expectations among many actors (Konrad, 2006). As an innovation process cannot be controlled by an individual actor alone, the collective expectations are an important source of coordination and legitimization (Konrad, 2006; Truffer, Voß & Konrad, 2008).

2.4 Mapping expectations about socio-technical transformations

Truffer, Voß & Konrad (2008) proposed a framework to identify individual and collective expectations within multi-actor transformation processes, see table 1. Truffer, Voß & Konrad (2008) combine MLP together with the social expectation dynamics as previously explained. By identifying the collective expectations, a common point can be set. Individual expectations can be used as substantiation for actors' specific actions (Bakker, 2014).

Table 1 Topography of expectations related to potential system transformations, differentiated regarding the level of analysis and the scope of social support, adapted from Truffer, Voß & Konrad (2008)

	Individual expectations	⟷	**Collective expectations**
Landscape	Individual beliefs about long-term trends	Projections of future context conditions as shared with specific actor groups (e.g. impacts of climate change as identified by scientific experts)	Broad societal visions about the future (Science fictions and utopias)
Regime	Individual beliefs about ability of regimes to respond to external pressures	Expectations shared with specific actor groups (e.g. associations of transport utilities about future sector structures)	Broadly shared visions about future sector structures
Niche	Individual assessment of development potential for specific innovative technologies and products	Hopeful alternatives preferred by certain actor groups (e.g. NGOs support for a future smart mobility)	Sectoral or national priorities in innovation policy to support "promising" technologies

Another distinction can be made between implicit and explicit expectations. Implicit expectations are unquestioned assumptions, for instance related to social, economic, and political conditions. Explicit expectations on the other hand are expressed by the beholder when considering alternatives (Truffer, Voß & Konrad, 2008), and can be researched.

2.5 Socio-technical scenarios

To eventually be able to compare the expectations, they will be presented in the form of scenarios. In this way the expectations are arranged in logical storylines and become manageable for comparison. By using the previously explained MLP as starting point, socio-technical scenarios (STSc) will be used. Within a STSc, possible routes for technological transition can be explored (Elzen, Geels & Hofman, 2002) and possible future developments can be described (Eames & McDowall, 2010) (see figure 4). It includes for example changing user patters, links between technical development and political development, links between various regimes enabling certain niche developments, etcetera (Elzen, Geels & Hofman, 2002; Elzen, Geels, Hofman & Green, 2004; Hofman, Elzen & Geels, 2004). Eventually a STSc is able support policy decisions aimed at realising a specific outcome.

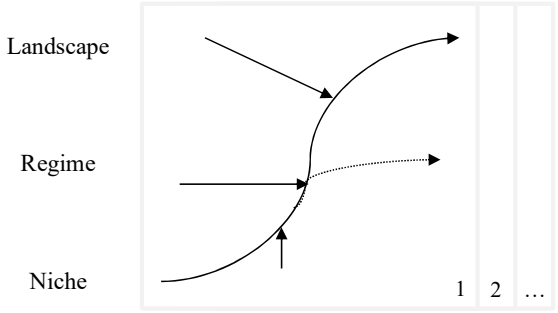

Figure 4 Socio-technical scenario

Traditional forms of scenario planning lack the qualitative aspects (Coates, 1989), there is too much focus on the past and not on discontinuity and radical change (Sapio, 1995; Ayres, 1989; Coates, Mahaffie, & Hines, 1994), the focus is on specific topics without looking at the broader system (Coates, Mahaffie, & Hines, 1994), focus on neo-classical economic approaches (Leonard-Barton, 1988; Nelson, 1995; Rosenkopf & Tushman, 1994), technology scenarios look at technologies independently (Pistorius & Utterback, 1997), and scenarios can have a "macro-bias" (Geels, 2002). Within a socio-technical scenario, qualitative elements are included, there is more focus on radical technological change, there is a broader system view by not focusing on an individual technology, and it includes meso-, micro-, and macro-dynamics (McDowall, 2014; Rip & Te Kulve, 2008). Compared to other scenario methods for a socio-technical transition, the STSc makes use of patterns and mechanisms within the previously explained MLP and makes it possible to explore why developments lead to certain outcomes (Elzen, Geels & Hofman, 2002).

To eventually get to a STSc several steps should be taken. There has been looked at three methods of constructing a STSc, from Elzen, Hofman & Geels (2002), Hughes (2013), and Geels, McMeekin & Pfluger (2020). Both Elzen, Hofman & Geels (2002) and Hughes (2013) are both qualitative based, while Geels, McMeekin & Pfluger (2020) also includes a quantitative part. Within this study the method of Elzen, Hofman & Geels (2002) is used as base, whereas the other two methods add on this where relevant.

Within the first step (see table 2), the purpose of the scenario building will be made explicit (Elzen, Geels & Hofman, 2002). Also, the choice of systems and countries are part of step one

(Geels, McMeekin & Pfluger, 2020). For this research, step two and three from Elzen, Hofman & Geels (2002) are combined, as identifying promising elements for transition is not the focus of this research. So, the combination of these two steps results in creating understanding of historical developments, potentially influencing the transition of, in this case MaaS, (Elzen, Geels & Hofman, 2002) and developing an overview of the current system (Hughes, 2013). These are specified according to the MLP, so the landscape, regime, and niche, to eventually be able to link this during scenario construction (Elzen, Geels & Hofman, 2002). The third step, is creating the scenario-skeleton, where rough contours of the scenario will be presented (Elzen, Geels & Hofman, 2002). From the scenario-skeleton, the scenario will be made in step four. These scenarios continue on the overview from step two, and are becoming storylines based on the MLP (Geels, McMeekin & Pfluger, 2020). The next step, step five, is to reflect on the scenarios, where main similarities and differences will be identified (Elzen, Geels & Hofman, 2002). The last step is the development of policy recommendations (Elzen, Geels & Hofman, 2002; Geels, McMeekin & Pfluger, 2020). See table 2 for the steps in the construction of socio-technical scenarios in this research. The construction of a STSc is an iterative process between these steps.

Table 2 Socio technical scenario construction

Step 1	Design choices and contours of the scenario
Step 2	Create overview of current system according to MLP
Step 3	Scenario-skeleton
Step 4	Make the scenario
Step 5	Reflect on scenarios
Step 6	Develop policy recommendations

3 Methods

3.1 Research design

The aim of this study was to identify expectations of involved actors in MaaS and identify similarities and differences between these expectations (Sochor, Strömberg & Karlsson, 2015). By taking expectations as the starting point of analysis, the implicit messages were captured (Van Lente & Rip, 1998). Within this study, the content of the expectations was the focus, as this is what eventually shapes further action (Van Lente & Rip, 1998).

A qualitative approach was chosen to study these expectations. By conducting a qualitative research, detailed and in-depth data could be obtained (Bryman, 2016). The aim of qualitative research was to explore the participants experiences and understand these (Flick, 2014). This study followed inductive reasoning, from the interviews. The previously explained MLP served as guidance for collecting and categorizing the data and eventually constructing the socio-technical scenarios.

For conducting this research, a case study design was used about MaaS in the urban areas of the Netherlands. With a case study design, an in-depth exploration can be derived from multiple perspectives about the complexity and uniqueness of a socio-technical transition (Simons, 2009).

3.1.1 Case selection

The urban areas within the Netherlands had been chosen as the case study. As the Randstad is the most densely populated 'city' of the Netherlands (PBL, 2016; CBS, 2019), the three pilots on MaaS in this region were researched. These are i) Utrecht-Leidsche Rijn, Vleuten and the Meern, ii) Amsterdam Zuidas and iii) Rotterdam-The Hague Including Airport., Amsterdam, Utrecht, and Rotterdam-The Hague. By selecting Randstad as a case, the urban area was covered. Within this study the focus was on the expectations of MaaS in the urban areas of the Netherlands of the involved actors.

To conduct this research, it was combined with an internship at the city of Utrecht. The city of Utrecht is involved in one of the MaaS pilots, namely the one in Utrecht-Leidsche Rijn, Vleuten and the Meern. By conducting the research from the city of Utrecht, the involved actors could easily be accessed and interviewed.

The first involved actor was the Ministry of Infrastructure and Water Management (I&W), which is the initiator of the MaaS-pilots within the Netherlands. Secondly, from every pilot researched, the municipalities were included, as they direct the local pilots within the cities. So, the city of Amsterdam, Rotterdam, The Hague, and Utrecht. Thirdly, each municipality had a collaboration with a contractor involved in improving the accessibility of the region. Lastly, each MaaS pilot had its own tender, for offering the MaaS pilot to a certain party. In figure 5, all involved actors within the pilots are visualized.

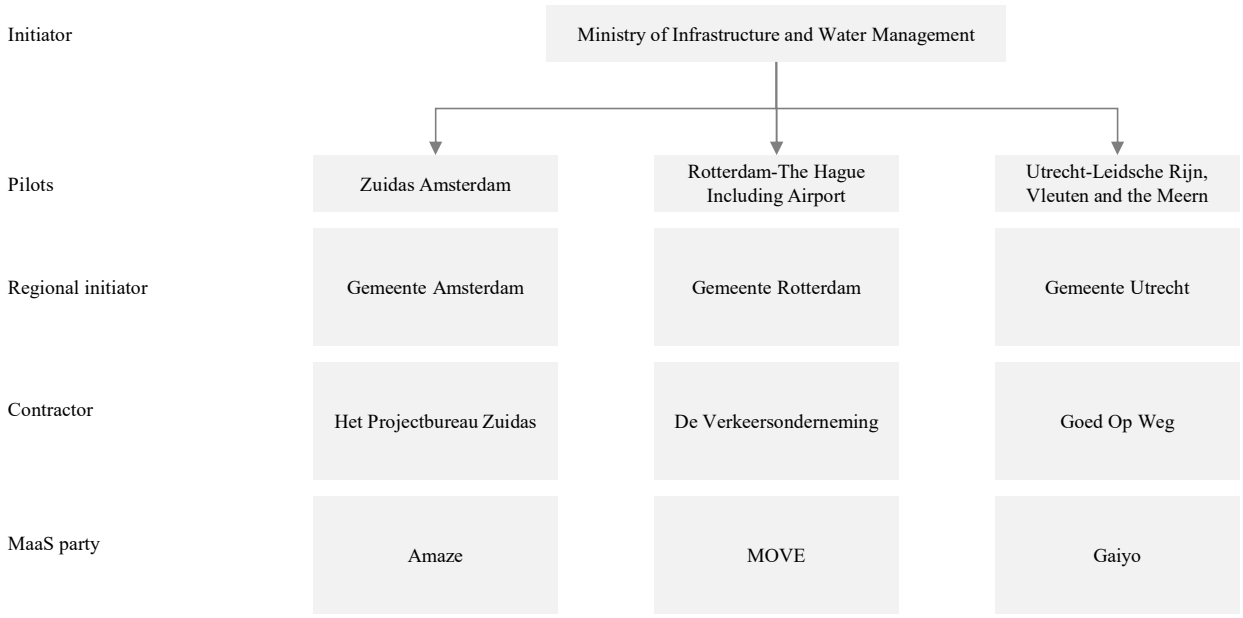

Figure 5 Structure of the MaaS pilots the Netherlands

To ensure the expectations were as complete as possible, the pilot specific actors were researched. When looking at the involved actors of MaaS explained by Kamargianni & Matyas (2017), research institutes and universities were not present within the selected case. By including them in the study, relevant expectations of many involved actors were included. As the transport operators were not directly present within the MaaS pilots but are within the core business of MaaS, as Kamargianni & Matyas (2017) stated, these were included as well.

For this study, the end-user of MaaS was not directly included. As the concept is relatively new, it should be explained, and the potential user would be biased through the explanation given on forehand. Thereby the expectations would not present the reality. Expectations about the end-users were derived through the other previously mentioned actors and documents on MaaS.

3.2 Data collection

This research consisted of four phases, see figure 6.

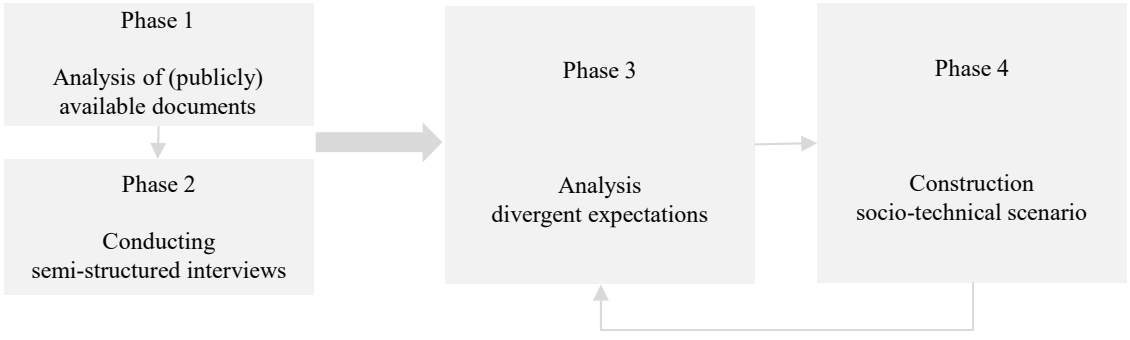

Figure 6 Structure of the research

Within the first phase, (publicly) available documents and pilot documents were used to identify expectations about MaaS and from there further define possible themes on the category's product, process, organization, and market (Van Lente & Bakker, 2010). The (publicly) available documents were derived through Google Scholar, Scopus, and Web of Science. There has been searched on the keywords "mobility as a service", "mobility as a service" AND expectations, "mobility as a service" AND innovation, "mobility as a service" AND urban, "urban mobility", and innovation AND mobility. Next to these documents, the pilot documents were derived through the MaaS pilot webpage, dutchmobilityinnovations.com, and the I&W webpage. See table 3 for the documents that were analysed until saturation of the expectation's categories was reached.

Table 3 Publicly available documents

Title	Author(s)	Year
Drivers and barriers in adopting Mobility as a Service (MaaS) – A latent class cluster analysis of attitudes	Alonso-González, Hoogendoorn-Lanser, Van Oort, Cats & Hoogedoorn	2020
Reprint of: The importance of user perspective in the evolution of MaaS	Lyons, Hammond & Mackay	2019
Mobility-as-a-Service and changes in travel preferences and travel behaviour	KiM	2018
Kansrijke groepen voor Mobility-as-a-Service	Zijlstra, Durand, Hoogendoorn-Lanser & Harms	2019
The rise of mobility as a service: Reshaping how urbanities get around	Deloitte	2017
Public transport regimes and mobility as a service: Governance approaches in Amsterdam, Birmingham, and Helsinki	Hirschorn, Paulsson, Sørensen & Veeneman	2019

In phase two, semi-structured interviews were conducted to gain insight into the expectations of the involved actors in MaaS. The themes extracted from phase one were used as guidance for the interviews. Nevertheless, a semi-structured interview allows the interviewee to address new topics (Bryman, 2016). The document analysis was used as input for the topics within the interview guide. See Appendix II for the interview guide. To select the interviewees, the case was used as a starting point and offered relevant interviewees concerning MaaS. Besides the interviewees derived from actors of the pilots, interviews were conducted with research institutes and universities, researching MaaS, as they were not present within the selected case. These interviewees were determined from documents used in phase one. In total, twenty-three interviews were conducted to get an overview of expectations of involved actors on MaaS. See table 4 with the interviewees. The interviews were conducted face-to-face where possible, if not through a call. See Appendix III for detailed information about the interviews.

Table 4 Interviewees

Science		Public Authorities		Market			
				MaaS		*Transport Operator*	
1	Planbureau voor de Leefomgeving	6	Ministry of Infrastructure and Water Management	13	Amaze	17	GVB
2	TU Delft	7	Gemeente Amsterdam	14	MOVE	18	RET
3	Radboud University	8	Projectbureau Zuidas	15	Gaiyo	19	Qbuzz
4	TU Eindhoven	9	Gemeente Rotterdam	16	Hely	20	NS
5	TNO	10	De Verkeersonderneming			21	Donkey Republic
		11	Gemeente Utrecht			22	Greenwheels
		12	Goed op Weg			23	Felyx

In phase 3, the expectations evolving from the semi-structured interviews were coded and the most striking differences in expectations were further evolved. Within phase 4 these expectations were used as input for the narratives of the socio-technical scenarios making differences in expectations even clearer. This was an iterative process, between coding the interviews and constructing the socio-technical scenarios. For each scenario striking differences were identified, concerning the speed and scale, the adopted roles by the actors, the transition pathways, and the support by the actor groups.

3.3 Data analysis

Within the first phase of the research, expectations about MaaS were derived from (publicly) available data. The documents were coded on the expectations mentioned in them (Bowen, 2009). This resulted in 13 clusters of expectations on MaaS. These are: characteristics of MaaS, effect on mobility, mobility system, users of MaaS, modalities development, regulatory framework, strategy towards MaaS, new business models for MaaS, changes within cities, challenges arising, other trends, pilots, and roles of involved actors. The document analysis continued until saturation of clusters for expectations about MaaS.

In the second phase, these clusters were used as guidance for the semi-structured interviews. By using an interview guide, the thread within the interviews were equal. All interviews were recorded, transcribed, and analysed, directly after the interview, to use the derived knowledge in subsequent interviews (Eisenhardt, 1989; Glaser & Strauss, 1976). The documents and interviews were coded within the software program NVivo, recommended by Bazeley & Jackson (2013). By coding the interviews, the data remains connected to the transcript (Corbin & Strauss, 1990). The expectations derived from the interviews were linked to the clusters derived from phase one where possible, if not, new themes were added. The expectations from phase one and two were used as input for phase three.

Within phase three, the most striking differences were identified. An individual expectation within this research is seen as an expectation from one single actor group. When an expectation is shared by at least two actors, the expectation is collective (Konrad, 2006). For the identification of divergences throughout the expectations, only collective expectations were used.

From there, in phase four, the classification of the expectations was used to construct scenarios. For the scenario construction, the steps explained in the theory were used. The first scenario development step is the design choices and contours of the scenario. Within this research the number of scenarios was not pre-determined and were constructed to cover all expectations. The focus within the interviews was on the year 2030 and after 2030, so the scenarios were constructed with these two moments in time. As previously explained, the focus was on the Randstad within the Netherlands. The second step, create an overview of the current system, was done according to publicly available data. The skeleton of the scenario in the third step was extracted from the most divergent expectations coming from the interviews. This was the first rough sketch of the scenario. When two expectations within a subtheme were the direct opposite, they were coded under scenario one and scenario two and so on. For example, “reduce car use”, and “more car use”, were divided into two different scenarios. The fourth step, writing the scenario, was done by subdividing the remaining expectations into the most corresponding scenario. As most of the interviews were in Dutch, quotes strengthening the socio-technical scenarios were translated. The fifth step, reflecting on the scenarios, was done by comparing and mentioning the most striking differences. The expectations of what scenario matched a certain actor groups’ expectation, so science, market or public authorities has also been reviewed. This was conducted according to the divergent expectations that were present in each scenario by the actor groups. Flowing from these socio-technical scenarios based on the expectations of the actors who were involved, theoretical and practical implications were given.

4 Results

In the results section, the outcomes flowing from the interviews are elaborated. From the twenty-three interviews, 143 unique expectations were found, see Appendix IV. From the analysis of the publicly available data, supplemented with the interviews, 13 different clusters of expectations could be derived. These 13 clusters are characteristics of MaaS, effect on mobility, mobility system, users of MaaS, modalities development, regulatory framework, strategy towards MaaS, new business models for MaaS, changes within cities, challenges arising, other trends, pilots, and roles of involved actors. See figure 7 for the distribution of expectations per cluster.

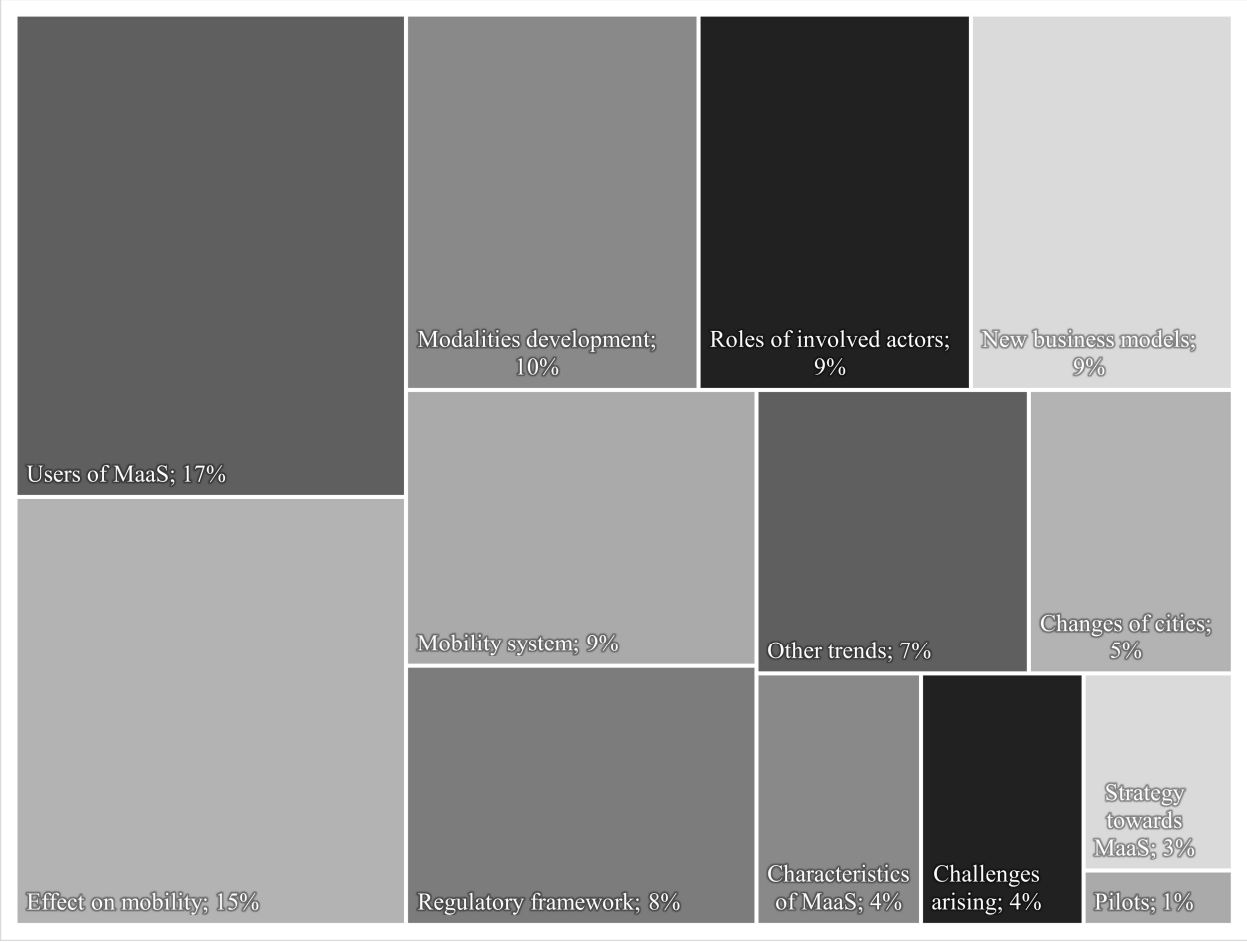

Figure 7 Distribution of expectations among clusters in percentage

From these expectations, divergences are identified and argued first, which is not the case for all the clusters. By using the divergent expectations, the scenario skeletons are constructed for MaaS in 2030 in urban areas within the Netherlands. With narrating the background of personal mobility and developments in the Netherlands, a better understanding is insured as the starting point of the scenarios. Each scenario is narrated, distributing the remaining expectations into storylines. A comparison has been made on striking differences in speed and scale, roles adopted by the involved actors, identified pathways per scenario, and the support per scenario of the interviewed actor groups.

4.1 Divergent expectations and scenario construction

4.1.1 Divergent expectations on Mobility as a Service

From the interviews, divergent expectations on MaaS have been identified. The clusters showing divergence are shown in figure 8, with the divergent expectations facing each other. Within the figure, the number of interviewees that have said something about a certain divergent expectation is perceivable through the two bars. The corresponding numbers are explained per cluster and divergent expectations.

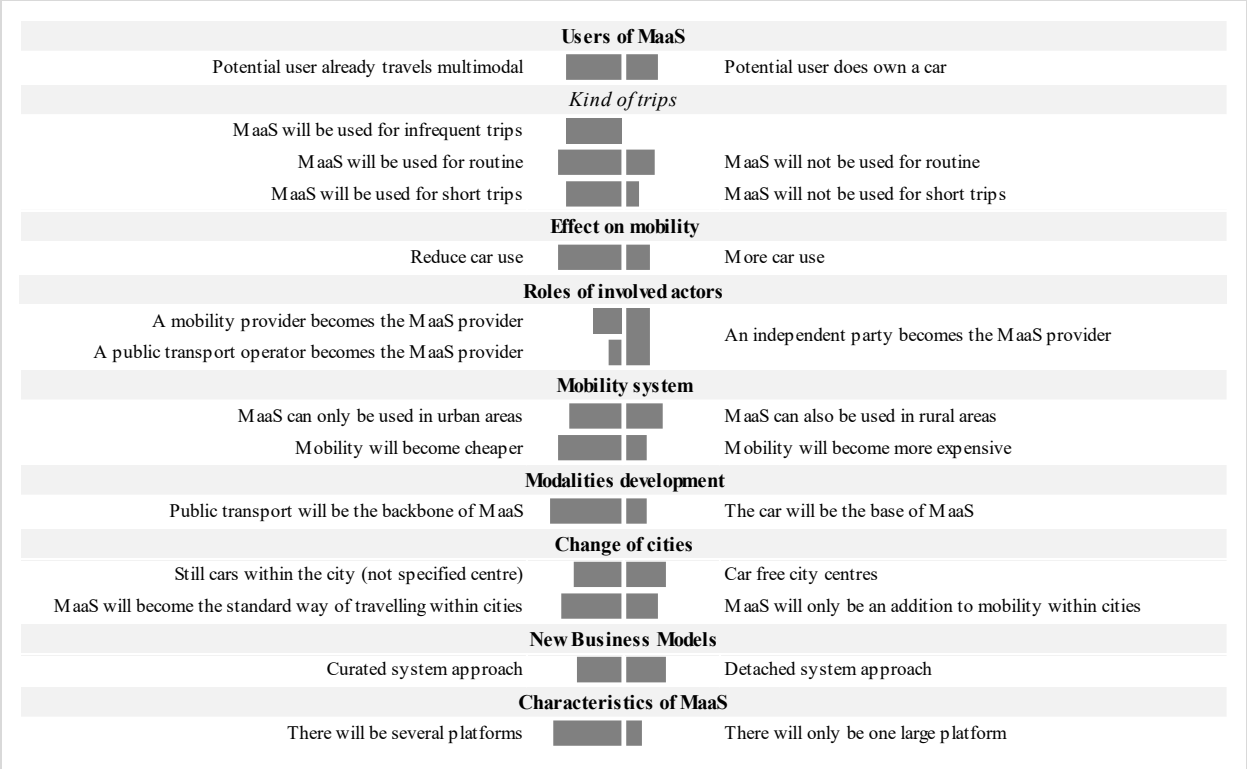

Figure 8 Overview divergent expectations

Users of MaaS

Within the cluster concerning the users of MaaS, two divergent expectations were identified. First, there is a difference in expectations about car ownership by users of MaaS. The largest group interviewees, namely 14, mentioned people who do not own a car have more potential to use MaaS, than people who do own a car. This group argued that people who do not own a car are already used to travelling multimodal. MaaS offers this group access to a car, without the need to actually own one. Opposite to this, a group of 8 interviewees stated the potential users of MaaS do currently own a car. According to them, MaaS could be an addition for car owners, and make them aware of other travel opportunities, which satisfy their needs. Eventually MaaS could offer the opportunity of sharing their owned car if it is not in use yet. These interviewees think the most benefits are visible for users owning a car.

Secondly, a division appeared on the kind of trips MaaS will be used for. Some interviewees, namely 7, reasoned MaaS could be used for any kind of trip, so infrequent trips,

routine, or short trips. There were, 4 interviewees that argued MaaS could only be used for routine or short trips, targeting two different kinds of travellers. And 4 other interviewees argued MaaS can only be used for routine trips, so to work for example. There were also 3 interviewees expecting MaaS will only be used for infrequent trips. Another 3 interviewees expected MaaS could be used for infrequent trips as well as short trips. Only one interviewee expected MaaS will be used for infrequent trips and routine trips, but not for short trips. And there was one interviewee expecting it will only be used for short trips.

Effect on mobility

Within the next cluster, the effect on mobility by MaaS, one divergent expectation came forward regarding the amount of car usage. In total 22 interviewees said something about this. On one hand, 16 interviewees argued MaaS reduces the use of cars in the coming ten years. According to this group, people will get rid of their second car, which means a reduction in car usage. On the opposite, 6 interviewees argued the car use would probably increase, especially towards 2030. The disappearances and behavioural change will take longer than ten years. During this transition more sharing opportunities, such as cars, arise, making it possible for non-car owners to have access to a car. As not all owned cars will directly disappear, an increase in car use will be sequential.

Roles of involved actors

The cluster concerning the roles of the involved actors in MaaS, contained one divergent expectation. Nine interviewees argued that the MaaS provider will grow out of an existing mobility provider. From these 9 interviewees, 2 argued a public transport operator will become the MaaS provider. They see public transport as the backbone of MaaS and therefore in the perfect position to become the MaaS provider. On the other side there were 5 interviewees arguing the MaaS provider should be an independent party. In this way, equal possibilities are in place for the mobility providers to integrate. There were 9 interviewees who argued that a mobility provider, public transport operator, and an independent party all have the potential to become a MaaS provider with each their own platforms in the future.

Mobility system

When looking at the mobility system cluster, two divergent expectations were identified. The first divergent expectation was about where MaaS could deliver mobility. Thirteen of the interviewees reasoned MaaS only has potential in urban areas. This is mainly due to the economic concentration of supply and demand within cities. On the other hand, 9 interviewees argued MaaS could also be used in the rural areas and increase the accessibility of these areas. According to them MaaS could replace loss-making public transport in these rural areas with other applicable solutions.

The second divergent expectation in this cluster was the change in price of mobility. Most of the interviewees, 16, expected mobility will become cheaper due to the arrival of MaaS. As the occupancy rate of vehicles can be increased, and the overall mobility system could be optimized with MaaS, mobility would become cheaper. Opposite to this, 5 interviewees explained mobility will become more expensive. They argued the MaaS provider would probably get their money directly from the client and thereby the tickets for the same journey will become more expensive.

As the MaaS provider guarantees a certain quality, these 5 interviewees argued the MaaS provider will ask for more money for the same journey.

Modalities development

The fifth cluster, development of modalities, was about what modalities will play a role in MaaS. This cluster had one difference in expectations among the interviewees, related to the predominant modality in MaaS. Most of the interviewees, 18, argued public transport will be the backbone of MaaS. Without a proper public transport network there is no possibility for MaaS to exist. The public transport is needed to transport the mass and is relatively quick. On the other hand, 5 interviewees argued the car will be the base of MaaS in the Netherlands. They stated the car is embedded in our culture, and to really let people shift to MaaS, recognition of modalities is needed to change their travel behaviour.

Changes in cities

As this research focused on urban areas, the changes within cities is one of the clusters, bringing two divergent expectations. The first one was about the presence of the car in cities, with an almost equal distribution among the interviewees. Twelve of the interviewees reckon cars would still have a place in the city and would not fully disappear. But there was also a group of 10 interviewees arguing MaaS will contribute to car free city centres. As MaaS offers other forms of mobility, such as micro-mobility, cars do not need any space in the city centres. A side note here is that the group of 12 interviewees arguing there will still be cars within the city, do not specify if this is about the city centre. The same applies to the 10 interviewees arguing city centres will be car free, but they are not saying anything about cars in the rest of the city.

Secondly there was the embeddedness of MaaS into the mobility regime. A group of 15 interviewees argued MaaS will become the standard way of travelling within cities. So MaaS is needed to travel among the city and in 2030 a large part of the journeys within, from and to cities are made with MaaS. The other group of 8 interviewees argued MaaS will only be an addition to mobility in cities. According to them MaaS is not going to prevail in the personal mobility, as people in cities mostly own a bike and might use MaaS if they are going to another city.

New business models

Some divergent expectations came forward in the cluster new business models, which arise from MaaS. The most divergent expectation in this cluster was what kind of insertion the MaaS provider has. The expectations about this were almost equally divided. The detached system approach was expected most, by 9 interviewees. This detached system approach means the MaaS provider owns the platform and connects the mobility providers and offers multimodal trips but leaves the responsibility of the actual trip to the mobility provider. The opposite expectation to this was the curated system approach, which was expected by 10 interviewees. With this approach the MaaS provider really delivers a total package towards the customer. Hereby the MaaS providers also does the marketing campaign and does the customer service. This was more seen as a collaboration between the MaaS provider and the mobility provider, wanting to give the customer a good experience. There was 1 interviewee mentioning there will be some MaaS providers

pursuing the detached system approach, while others choose for the curated system approach. Eventually there will be a mix of these two in the market of MaaS providers.

Characteristics of MaaS

Lastly, in the characteristics of MaaS, one divergent expectation about how many platforms there are going to be in the Netherlands, has been identified. There were in total 21 interviewees that said something about this, whereas most of them, namely 17, argued there will be several MaaS platforms within the Netherlands. According to them, several platforms will be better for the market forces and thereby better for the customer. On the other hand, there were 4 interviewees expecting only one MaaS platform will exist in the Netherlands. They expect that one party conquers the market and due to the market forces, they can take advantage of the development from the pilots. Striking about this is the fact that from the 17 interviewees expecting there will be several platforms, 9 interviewees also mentioned the risk of market forces as a challenge and the possibility this would happen. So, despite they expect the government to regulate the market is such a way there will be several platforms, they also see the risk of eventually ending with one platform.

4.1.2 Scenario construction

These divergent expectations were used as a starting point for the scenario construction. Three different scenarios evolved from these expectations, see table 5, and they will shortly be explained.

Table 5 Scenario distribution evolved from the divergent expectations

	Expectations / *Scenarios*	1	2	3
Users of MaaS	Potential user already travels multimodal	×		×
	Potential user does own a car		×	
	MaaS will be used for routine		×	×
	MaaS will not be used for routine	×		
	MaaS will be used for short trips	×		×
	MaaS will not be used for short trips		×	
	MaaS will be used for infrequent trips		×	×
Effect on mobility	More car use	×		×
	Reduce car use		×	
Roles of involved actors	An independent party becomes the MaaS provider	×	×	×
	A mobility provider becomes the MaaS provider	×	×	
	A public transport operator becomes the MaaS provider		×	
Mobility system	MaaS can only be used in urban areas	×		×
	MaaS can also be used in rural areas		×	
	Mobility will become more expensive		×	×
	Mobility will become cheaper	×		
Modalities development	The car will be the base of MaaS	×		
	Public transport will be the backbone of MaaS		×	×
Changes of cities	Still cars within the city (not specified centre)	×		×
	Car free city centres		×	
	MaaS will become the standard way of travelling in cities		×	
	MaaS will only be an addition to mobility within cities	×		×
New Business Models	Curated system approach		×	
	Detached system approach	×		×
Characteristics of MaaS	There will only be one large platform			×
	There will be several platforms	×	×	

The first scenario is *"A customized add-on to mobility"*. When looking at 2030, there will be several MaaS platforms within the Netherlands, with a platform approach. This means the MaaS provider connects the transport operators with the user but does not directly influence the quality of the transport. Mobility would become cheaper, due to the economic concentration of supply and demand in urban areas. As the urban areas are densely populated, while rural areas are not, MaaS will only be present in cities. The MaaS platform is built around the car, as there is lower car ownership in cities, the focus will lie on the people not owning a car and already try to travel multimodal. Because car sharing will increase through MaaS, more people would eventually use a car. Also, as MaaS is only present in cities, it is not focused on replacing a routine, but on the short trips within a city. MaaS will become an addition to mobility within cities. In this scenario, the market will take the lead and the government supports the development.

Secondly, there is the scenario *"An alternative to car ownership"*. In 2030, several MaaS platforms have evolved within the Netherlands. They have a curated system approach, meaning they actively attract customers and deliver high quality transport and support. These agreements and guarantees make MaaS expensive, so especially in 2030, the customer must still pay for this. On the other hand, as people owning a car are the ones attracted and seduced to other behaviour, city centres have become car free and the overall car use is reduced. As public-private partnerships are in place, and there is as close cooperation between the market and the governments, MaaS is also offered in rural areas. Public transport is the backbone in this scenario, as this is the cheapest way of moving the mass. In 2030, MaaS will be the standard way of travelling, in, from and to cities.

Lastly, the third scenario is *"A winner takes it all"*. A large (international) company saw the opportunity of MaaS in the Netherlands and benefited the developments of the pilots. By 2030 they have conquered the market and made it difficult to compete due to prices. As this company has enough money, they can absorb losses. This company chose to focus on people not owning a car in cities, wanting to easily travel multimodal. As the government has not much influence, the large company has focused on car sharing, which resulted in more car use. Therefore, there will still be cars in the cities. MaaS has just became an addition to mobility within cities, outside the reach of the government.

During the scenario construction two striking differences raised. The three scenarios were plotted against these two axes, see figure 8, to better understand the differences between the three.

i) The degree of transformation of the mobility system compared to the current mobility system. Within the transformed mobility system, infrastructure, number of vehicles, types of modalities, regulations, etcetera, are transformed into a new mobility system. Here, the users changed their travel behaviour and the mobility system radically changed. Opposite to this, it was also possible the mobility system did not transform and stayed the same as the current mobility system.

ii) The public versus private axis, and their influence on the development of MaaS. On the left side of the axis there are the public authorities, so the government has total control on the development of MaaS, regulations are for the benefit of MaaS.

When the private parties have the most influence, it would be a market party which brings MaaS to the market and rules the market and the impact of MaaS. In the middle between government and market there would be well-balanced public-private partnership.

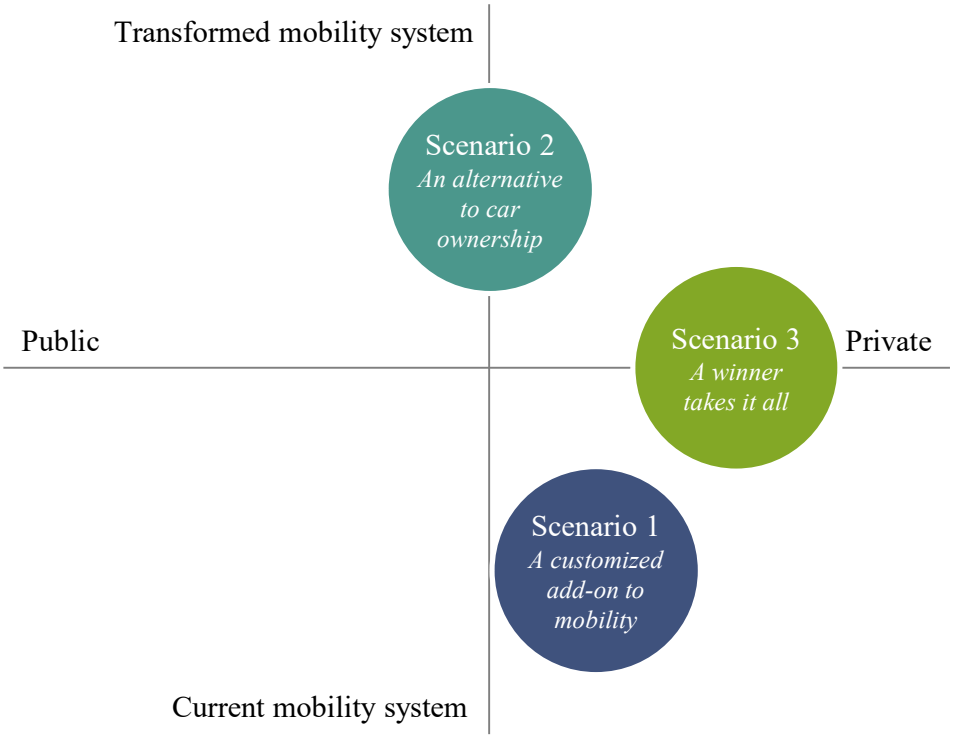

Figure 9 The socio-technical scenarios on MaaS

The remaining expectations, shown in Appendix IV, were fit into these three scenarios, see Appendix V.

4.2 Narrative socio-technical scenarios on personal mobility in the Netherlands

4.2.1 Personal mobility in the Netherlands from 2010 till 2020

The car had a prominent role in the Netherlands the past ten years and most kilometres travelled by citizens in the Netherlands were done with it (CBS, 2017). This was not surprising, as in the 20th century, the arrival of the car was central. But times changed and the 21st century, also known as the digital age, raised opportunities (Deloitte, 2017). Due to digitization, and the availability of data, the efficiency of travelling could be increased, by not only using the car (Deloitte, 2017). More user centred transport solution started to develop. People have been moving towards cities, and the digitization was something that could support the coming issues, like sustainability, congestion, and air pollution by cars. Also, electrification started, and together with digitization has been changing the personal mobility, with for example electrical vehicles and autonomous vehicles (PWC, 2018; McKinsey, 2019; Li & Voege, 2017)).

But the consumer preferences changed as well, influencing the development of mobility. People did no longer think through the either/or prism, but chose the transport modes, and combined these to their personal preference (Sierpiński, 2011; IPSOS, 2019). They needed several apps and a lot of perseverance to travel multimodal. Different transport modes have been developed due the electrification and digitization trends and are increasingly accepted by the citizens (Lenz & Fraedrich, 2016). Combining different transport modes is expensive when owning each possibility, so sharing mobility increased as well. There was no ownership needed to have access to a lot of different transport modes (Hamari, Sjöklint & Ukkonen, 2016; CROW, 2018). Apps concerning journey planning, and combining different modalities started to arise, and were embraced by citizens (Matyas, 2020).

Besides the consumer, governments also saw the urgency for more sustainable mobility solutions, instead of just expanding infrastructure (I&W, 2017b; I&W, 2019a). Cities started looking at introducing environmental zones, banning polluting cars within certain parts of the city (I&W, 2019b). The cities started supporting electric vehicles and for example provided the charging infrastructure for cars. Besides, they supported the public transport within cities, as well as the pedestrians and cyclists. All cities wanted to increase the liveability, the green and playing, clean air, and decrease cars parked as well as driven. Since the concept MaaS came to light, governments shifted their focus due to the promising influence on the future mobility system. This resulted in the start of the seven MaaS pilots throughout the Netherlands, initiated by the Ministry of Infrastructure and Water Management. Together with market parties and transport operators, it has been tried to learn about MaaS (I&W, 2019a).

4.2.2 Scenario 1 – A customized add-on to mobility

2020-2030 – The rise of MaaS

During the pilots, it turned out, the ones focusing on cities, were more successful than the others. But the pilots were a steppingstone for the market to establish a good foundation for further developments. Public-private partnerships created during the pilots were still in place, but not as closely related as during the pilots. A few pilots succeeded and individually developed into several MaaS platforms in the Netherlands. *"Well, I do expect that multiple platforms can coexist and that even more apps can exist because you also have different user groups, different apps."* (2) [1] Beside the MaaS providers from the pilots, other MaaS providers came to the market. Every MaaS provider has its own target group, and price agreements with mobility providers. There also have emerged two different approaches, the detached system approach, and the curated system approach. The MaaS providers with a detached system approach left the actual transportation and coming customer service to the transport operator. On the other hand, some MaaS providers took the curated system approach, whereas they wanted the best experience for the customer, and they bought mobility from the transport operators, but arranged their own customer service. The MaaS app is in place, but it is not widely known. Because there has been too much focus on technology and the user is lost out of sight, user acceptance is still a challenge.

Each platform had its own focus, some focused on the business traveller, mainly on the employer, whereas other platforms focused more on the people not owning a car but wanting to travel more flexible. *"... people see their car as some kind of status symbol, making them want to keep their own car, and these people are not using mobility as a service"* (19). Through MaaS these target groups got access to mobility, meeting their needs, on any time they wanted it. They got the opportunity to see the different mobility options and combine different modalities, resulting in more customized mobility. So imagine like *"... you are on A, you want to go to B, you look in your app and enter the location you want to go to and you get a suggestion, like okay, combine for example first the bike and then the train and then the scooter to get to the destination."* (20).

Despite the fact a few MaaS platforms exist, it has not yet achieved the effects that were expected in advance. *"... we have to look at 2030, ... we are seeing for example in the Netherlands there are these new pilots, short track to fuel the development of this service. So probably yes in 10 years, so we can have some services which are offering MaaS ecosystem."* (5) The car use increased, since the access to cars has increased, through the increase of sharing mobility. *"If you target the choice traveller and you make the use of carsharing easier, than the opposite effect maybe arises, because people think oh I suddenly see so many shared cars in the neighbourhood, that is easy I am going to use it more often."* (13) This has also resulted in the fact that there is more use of passive mobility services than before.

MaaS was mainly used in urban areas, due to the economic concentration of supply and demand, and therefore profit could be made by transport operators. This resulted in the mobility spending's of citizens staying the same or even decrease. As MaaS was mainly available in urban areas, it became an addition to mobility within cities, but not to everyone. The car still had a

[1] The number is not corresponding with the table in the Methods section, due to anonymity of this research.

prominent role and became the base of MaaS. *"Maybe later, everyone travels with MaaS, and if now 80% of the trips are with the car, yes than it might be 60% in 2030. But people who think MaaS mainly occurs from existing public transport apps and will never be used by car drivers, yes they would think that public transport will be the dominant modality in MaaS, but I think that navigation apps and travel-apps migrate to each other, and well yes that the car will stay dominant for a very long time. But hopefully we can steer a bit more on carsharing or ridesharing and then so on sustainability and an increased occupancy rate"* (4) But all modalities were included in MaaS, like public transport, sharing mobility, the taxi, and owned modalities. Because MaaS was only available within cities, it was not used for routine trips, but more for short trips within a city. As the regional government facilitates MaaS through integrating it in new area developments, more coverage of modalities was granted.

Also, the regulatory framework has changed. During the pilots, the TOMP API was developed, to stimulate the standardization and the level playing field. The TOMP API became obligated, together with the open data policy, which made all the actors share their data, with the goal to eventually optimize the mobility system. But after the pilots, the government decreased the direct financial support of MaaS, whereby the new regulations on data sharing and obligating the TOMP API, had the opposite effect. It became hard to connect the large sharing mobility companies, as these already had developed their own APIs, resulting in only smaller businesses, and start-ups connecting to the platform. Besides the standardization included price agreements, which made it more difficult to stand out as a MaaS provider.

2030-2040 – In violation with the car

From here onwards, the MaaS providers further developed their platforms and applications. New functionalities were added to serve the customer. In 2040, the MaaS provider had become a virtual travel assistant. *"… mobility in 2040 you know and then, where I always start is some kind of virtual travel assistant."* (22) As the regulatory framework still does not complement MaaS, it has been made difficult to really stand out as MaaS provider. The government has been focusing on other developments, to achieve policy goals, as MaaS was not seen as the most efficient way. *"You know, there are just other ways to achieve the same goals of sustainability, and then the question is whether MaaS is the best tool, the most efficient so to say."* (18) The arrival of autonomous vehicles became an addition to the car based MaaS system.

4.2.3 Scenario 2 – An alternative to car ownership

2020-2030 – Battle the car

The pilots turned out, pressures arising from the landscape level, such as the climate change and urbanization, were too large to get solved by the market. MaaS was the solution for *"world peace"* (4) in mobility world. Public-private partnerships emerged during the pilots to conquer the market. *"It could solve congestion, pressure on public transport, reduce CO_2 emission through electric cars, promoting electric bicycles, through promoting sharing."* (4) After the pilots, the public-private partnerships grew even further and became stronger, developing into an ecosystem. *"So it is really, the MaaS ecosystem, is an interplay of all kinds of parties, working on making mobility smarter and more sustainable, and in particular also be able to meet the mobility needs of the user, to make them travel smarter and more sustainable."* (22) The MaaS provider, mobility providers and government worked together to balance and optimize the mobility system. They provide access to mobility and unburden the users regarding mobility. Several platforms emerged in the Netherlands, whereas a few remained from the pilots and scaled up afterwards. *"... which parties from these seven pilots will eventually remain. ... it is a good start and that it will continue to develop from there."* (2) In most cases, the customer interface of MaaS appeared as an application. Most platforms handled a curated system approach, *"as Maas provider you say, you are my client and I arrange your mobility, and ... I connect myself with partners and parties, which I know they could deliver quality services I want to offer you, and if I say there will be a taxi, or if I say there will be a scooter, than you can address issues to me if something is wrong. And who does this on the background, you as a customer do not have to worry about this, because I am your MaaS provider."* (16)

As many issues, such as accessibility, liveability, congestion, and air pollution evolved from the urbanization, people owning a car were targeted, as they could really make a change. *"One of the things that will only get worse in the coming years is the crowds in the cities. So that is basically unstoppable for the time being, and urbanization leads to quite a distance, or various problems in cities. And as government or municipalities or cities, they will have to take measures to organize that. And also, mobility within the city, or actually from another perspective, defending or guaranteeing the competitive position of the city, they will have to regulate this, or they will have to come up with solutions. ...MaaS may be one of those solutions ...."* (21) MaaS had to battle with the image of the car, like flexibility and easy to access, and strived to fulfil these needs for consumers. *"... for a lot of people, you have to compete with their own car, and that flexibility and independence is simply great."* (13) By targeting car owners, MaaS developed in an alternative to car ownership, and in combination with the trend from ownership to access, and reduced the car ownership, mainly within cities. *"Well that trend that I, let say that from ownership to access that is of course a trend that not only plays a role in the mobility world, but also in many other things. ... We no longer have CDs at home, or no DVDs, ..., we no longer own those things ourselves. And you can see that in many other sectors too, from ownership to access"* (23) This resulted in a reduction of car use, in, towards, and from cities, and a growing user acceptance. MaaS made it able to combine different modalities and have insight in the different mobility options to get to a

destination. MaaS could be used to plan your day, so infrequent trips, as well as routine trips. With the growing sustainability concerns, MaaS made it able to choose a journey according to impact, so for example emissions. This resulted in more customized mobility, serving everyone's needs.

MaaS has become the standard way of travelling, towards, from and in the cities. The urban infrastructure has been redesigned, with hubs outside the city for cars, and seamless transfer to first and last mile solutions. Within the cities there more space became available for pedestrians and cyclist, it became greener, and city centres became car free. *"... it is just important we share more with each other, cars, bicycles, because it just becomes more crowded in cities. So, we must ensure that we deal with the space in a smart way and that cities are also becoming much nicer to live in. So greener and environmental friendlier transport modes, and to do that we will have to live ... together more efficiently, so we will have to share more."* (10) The regional governments responded to moments to change behaviour, like a new job or a new house. By integrating MaaS into these moments, in ten years' time, it made citizens change their travel behaviour. The public transport innovated, and the term has been broadened, since sharing mobility has become part of it. The increase in sharing mobility was a trend the past years, and in combination with the traditional public transport, has become the backbone of MaaS. But not only for cities, also the rural areas are served by MaaS, embedding more inclusive mobility. Here the unprofitable busses have been replaced by sharing concepts, where possible. Also, as MaaS includes all modalities, like public transport, taxis, sharing mobility, but also owned modalities, it can serve and satisfy customer needs. This all is not free, and mobility has become more expensive.

When looking at the regulatory framework, a lot has changed. During the pilots everything has been prepared for the obligation of the TOMP API, making it able for smaller companies to become part of the ecosystem as well. Through the open data policy, established during the pilots, a lot can be learned about travel behaviour. From this data, subsidies were rearranged, and deployed more specifically where needed. The government still supports the MaaS ecosystem financially. With external stimuli, the government tried to seduce the user until they were convinced of the benefits of MaaS. With new regulations, the car has been made less attractive, due to an increase in price, or even dynamic pricing.

2030-2040 – The emergence of a collective mobility system

Towards 2030, a good base has been made for a more collective mobility system. Users got to know MaaS and learned how to use it. The next step will be to steer on behaviour, for a collective mobility system and the achievement of policy objectives. There is mass needed to be able to do this, and in the last ten years, most people started using MaaS. In this way, the government can optimize the system and increase the occupancy rate of vehicles, and eventually reduce mobility needs. This eventually results in mobility becoming cheaper. The user can get a proactive travel advice, according to their agenda, the weather and based on other persons' agendas and predicted journeys. Users are more willing to ride along and share modalities, they still own, with others. But the owned modalities have decreased a lot. To serve customers on demand, autonomous vehicles became an addition to MaaS. MaaS also started to support cross-border mobility and included airplanes. An EU wide standard has been developed and implemented.

4.2.4 Scenario 3 – A winner takes it all

2020-2030 – The take over

After the pilots, a large international company saw the opportunity of MaaS in the Netherlands and all the preliminary work done in the pilots made it easy to gamble. *"Yes and for all you know those pilots will be nothing at all and there will be a party from the right who does not participate in the pilots at all and who will win the heart of the customer, what do you have as a government and if, because you are not obliged…. So yes, for the same goes it alongside and then, hey."* (21) After some years of competition with the MaaS providers from the pilots, none of them succeed and the large international company conquered the market. The MaaS provider adopted a detached system approach, whereby transport operators are shown through the MaaS application, but the MaaS provider is not responsible for the transport itself and the coming customer service. As the MaaS provider is a large international party, with enough money, they had the power to only allow the transport operators performing to their standards and requirements. This made the integration of cross-border mobility easier.

The focus lied on people not owning a car, giving them access to every modality they needed and gave insight in the mobility options. Through the MaaS app, the users could choose and combine these modalities to get to their destination. This meant more customized mobility for the user. This eventually caused an increase in car use within cities, by granting access to those not owning a car. An increase occurred also in the use of more passive mobility services, as people in cities already own a bike, as this is the cheapest. As the MaaS provider eventually became the only one on the market, they determined their own prices, and made mobility more expensive.

As the economic distribution of supply and demand within cities is close, and thereby the low hanging fruit, there is a main focus on urban areas. With MaaS only being an addition to mobility in cities, it did not become an addition to everyone. The MaaS provider made use of what was already in place, like the public transport, and the sharing opportunities. The public transport became the backbone of MaaS, but as the government was not directly involved, public transport could not handle the pressure. Sharing mobility use increased as an addition to the public transport. Since the MaaS provider is not responsible for the vehicles on the street, the pollution of the public space by the vehicles was not addressed to them. Besides public transport and sharing mobility, all other possible modalities were included as well, like the taxi and owned modalities.

No regulations were in place to prevent this from happening. As the MaaS provider only owns the digital part, they cannot be banned or limited physically. Besides, MaaS also had the potential for achieving policy objectives, so the government did not want to fight it. This was not the first intention of the pilots but MaaS became an option for travellers.

2030-2040 – It ripples on

"Eventually, I think, the winner takes all. Eventually, but that is not there yet. A lot of money is going to be burned by a lot of people to eventually create such a platform." (21) So, MaaS came to the point in which one party took over the market. The only thing the government could do was trying to limit the power and focus on optimizing other parts of the mobility system which were within their power.

4.3 Comparison of the socio-technical scenarios on MaaS

When looking at all three scenarios some similarities and differences came forward regarding the speed and scale of the MaaS development, the roles of the involved actors, the transition pathways in each of the scenarios, and the support per scenario of the interviewed actor groups, so public authorities, market and science. These will be further explained.

4.3.1 Speed and scale per scenario

When looking at the three scenarios, a difference can be observed concerning the speed of the MaaS development. In *a customized add-on to mobility*, the development went fast during the pilots, but due to "over regulation", and the government taking more distance from MaaS, the development speed decreased after the pilots. This resulted in *a customized add-on to mobility*. However, the initiated goals, like decreasing car use, are not yet achieved in 2030. Comparing this to *an alternative to car ownership*, whereby these goals are partially achieved in 2030, and the government is still actively involved with the MaaS development. Within this scenario the speed of the MaaS development stayed almost the same as during the pilots. The lines of communication that were set up during the pilots made sure the development could continue in the same speed afterwards. When looking at *a winner takes it all*, the speed of the MaaS development also decreased after the pilots. Hereby, the focus was more on competing against a large party, causing distraction from the development of MaaS. So, in both *a customized add-on to mobility* and *winner takes it all* the speed of the MaaS development decreased, compared to the speed of MaaS development during the pilots. In both cases, this was due to shift of focus, in *a customized add-on to mobility* towards other developments, and in *winner takes it all* towards a possible threat.

Another difference between the three scenarios is the scale of MaaS. Within *a customized add-on to mobility* MaaS was only an addition to mobility within urban areas. It did not replace any modality, but it just made it easier to travel multimodal. This was almost the same within the scenario *a winner takes it all* where MaaS only became available in urban areas. As the MaaS provider was a larger company with monetary assets it was possible they would transform the mobility system in some way. Lastly, *an alternative to car ownership*, had a totally different scale. MaaS became available throughout urban areas, but it also replaced owned modalities, mainly the car. From, to and within cities MaaS became the main way of travelling, and MaaS also got potential in rural areas.

4.3.2 Adopted roles by actors

Looking at the roles of the involved actors within the three scenarios, differences can be identified. Starting with the role of the national government, as initiator of the MaaS pilots within the Netherlands. In all three scenarios the national government regulated MaaS. This was mainly done through maintaining and pursuing the agreements made during the pilots, regarding standardization of the language and the open data policy. In this way the national government wanted to create a level playing field. Within the scenario *a customized add-on to mobility* these agreements also included price agreements, so the government predetermined the price of a transport mode. By doing this they tried to create a level playing field. This is something that has not been done in the other two scenarios. The national government gave responsibility to the

market to further develop MaaS. Within the scenario *an alternative to car ownership* the national government also facilitated the MaaS development in the Netherlands. This means MaaS is integrated in the subsidization of mobility, which therefore need to be rearranged. Mobility in this scenario was an entirety instead of separate islets. The government used MaaS to optimize the mobility system based on the data from the ecosystem. This was done for example by replacing unprofitable bus lines by a profitable mobility option. The role of the national government in *a winner takes it all* was totally different than in the other two scenarios. With the pilots, the government tried to speed up the development and standardization, but this also gave an opportunity to a private company. The role in this scenario for the national government is trying to minimize the power of the private company, instead of focusing on the opportunities of MaaS.

The regional government, so the provinces and municipalities, accomplished a different role in de three scenarios after the MaaS pilots. Looking at the scenario *a customized add-on to mobility* the regional government mainly focused on the transport operators and their facilitation. For example, the distribution of space in a city for different modalities. The sharing concepts were promoted throughout the city and many new area developments included them. This is done detached from the MaaS provider, as there were no strong partnerships in place to work together. This is different in the scenario *an alternative to car ownership* where there were public-private partnerships and together they worked on achieving policy goals. MaaS really became an ecosystem, where collaboration and trust in the MaaS provider was present. So, through this collaboration the regional government complemented the needs of the MaaS provider to eventually be able to achieve the policy goals, regarding sustainability. By integrating MaaS throughout the city, all transport operators were obliged to connect with the MaaS provider and share their data, which was included in the agreements. Within the scenario *a winner takes it all* the regional government focused on the sharing concepts within cities and integrating these into new area developments. The obligation of open data policy was still in place, but as the new MaaS provider was not involved with the pilots it did not have to share their data.

The role of the MaaS provider in all three scenarios is to offer mobility towards customers, but this role is fulfilled in different ways throughout the scenarios. Within the scenario *a customized add-on to mobility,* the MaaS provider tried to increase the reliability and attract more customers. This was mainly done from a business perspective, and not for the achievement of policy goals. The MaaS provider tried to improve their services towards the customers. When looking at the scenario *an alternative to car ownership* the MaaS provider was within an ecosystem and decisions were weighed according to the impact on the other actors in the ecosystem, like the government, transport operators and users. The MaaS provider offered mobility in collaboration with transport operators and governments. Together they determined according to the data where mobility was needed and tried to connect and round out the advantages and disadvantages. Everything came together at the MaaS provider. The MaaS provider in the scenario *a winner takes it all* was an independent party and was separate from what has been happening in the MaaS pilots. They connected transport operators by themselves, so not through the TOMP API. As the MaaS

provider was a private party, probably with enough monetary assets, the low margin within the MaaS business and sharing operators was not a barrier for them.

Another involved actor in the scenarios are the transport operators, who are physically delivering the different transport modes. So, these are for example the current public transport operators and sharing mobility parties. The transport operators had diverse roles in the different scenarios. The transport operators in scenario *a customized add-on to mobility* were delivering mobility and sometimes collaborated with the MaaS providers, but this depended on the approach taken by the MaaS provider. There could be said this is how things go now and there did not change that much. This is comparable with the scenario *a winner takes it all* where the transport operators get connected with the MaaS provider. As the MaaS provider was a large international party, there was the possibility some of the transport operators were bought up. This was different in scenario *an alternative to car ownership* where the transport operators were closely interacting with the MaaS providers and constantly trying to increase their quality, reliability, and service towards the customers. The interplay between the MaaS provider and the transport operator ensured the mobility system was accessible to everyone and could be organized in an efficient way.

The requirements from the users are different within the three scenarios, and thereby their roles as well. To start, users wanted to travel from A to B, whenever they wanted and wherever they wanted. This was the starting point of MaaS. But when looking at the scenario *a customized add-on to mobility* the attracting of customers really happened through focusing on potential user who want to travel multimodal. So, the users searching for unburdening of their mobility planning and travelling end up at the MaaS provider. The users were not forced to look for alternatives but travel through MaaS based on their intrinsic motivation. While looking at the scenario *counterpart of the car* it also started with the users searching for it, but later, the government also integrated MaaS into new area development and offered MaaS as an alternative for less or expensive parking's in cities. Here the users, also the ones currently owning a car, were enforced to actively search for new alternatives. As MaaS developed in a reliable service, it was adopted as alternative for the car. This needed the necessary dedication from the users. To be able to get the best mobility options, adjusted to other user's mobility needs, users should always plan their trips. This could be partially unburdened through connecting with your personal agenda, but this also needed some change in user behaviour, regarding trust around data privacy. Eventually, when MaaS was integrated in such a way the government steered on behaviour, and trust is expected from the user. So, in this scenario, planning was expected from users and changing their travel behaviour. The role of the user in the last scenario *a winner takes it all* was comparable with the role of the user in the first scenario. Users were not really forced to look at alternatives but were searching for it from personal interest in for example sustainability. MaaS unburdened the users looking for easy to use multimodal travel options.

4.3.3 Identified transition pathways per scenario

The starting point, intentions and first developments were the same within all three scenarios. When looking at the transition pathways, all three scenarios started as a *transformation* pathway. There was moderate landscape pressure through the urbanization, congestion, and

climate change. The niche innovations regarding MaaS were not well developed, there were just a few MaaS providers developing the platforms and interfaces. With the pilots, the regime actors concerning mobility adjusted their directions of innovation and development. As the Ministry of Infrastructure and Water Management implied the pilots, opportunities were not only raising for actors already active within the regime, but also actors from outside the regime got a chance. Despite all three scenarios started as a transformation pathway, the further course differs.

In the first scenario, *a customized add-on to mobility*, the transition further evolved as a *reconfiguration* pathway. The innovation, MaaS, further developed in a niche, and eventually was adopted in the regime to solve local problems. In this scenario, MaaS only became an add-on to the personal mobility regime but left most of the regime unchanged. Several innovations were needed to change the overall regime, but these were not in place and did not came together in this scenario.

Within the second scenario, *an alternative to car ownership*, after the transformation pathway as start, the *de-alignment and re-alignment* path raised. The de-alignment and re-alignment occurred, as the landscape pressures increased, leading to problems within the existing regime. This led to space for multiple niche-innovations, like the development of new modalities, and the further development of MaaS, to co-exist. One of the niche-innovations became dominant, in this case MaaS, and formed the new core of the mobility regime.

The third scenario, *a winner takes it all*, also further evolved as the *reconfiguration* pathway, like *a customized add-on to mobility*. MaaS in this scenario grew out of the old regime but did not change the overall personal mobility regime. This was mainly because the MaaS provider was a private party and was not externally stimulated by for example the government to achieve policy objectives.

4.3.4 Support per scenario by the actor groups

For the comparison of support per scenario by the different actor groups, the divergent expectations were looked at. These have less overlap than the distribution of the remaining expectations, whereby the divergence in expectations are used in figure 10. The percentages are based on the number of quotes in each of the scenarios per actor group. There can be seen all actor groups mainly expect the second scenario *an alternative to car ownership*, as most of the quotes from the divergent expectations are in this scenario. The expectations concerning the other two scenarios are more divided. Within science there is almost an equal distribution of divergent expectations in *a customized add-on to mobility* and *a winner takes it all*. The public authorities lean a bit more to *a winner takes it all*, whereas the market leans more to *a customized add-on to mobility*. So, the expectations are different across the three actor groups.

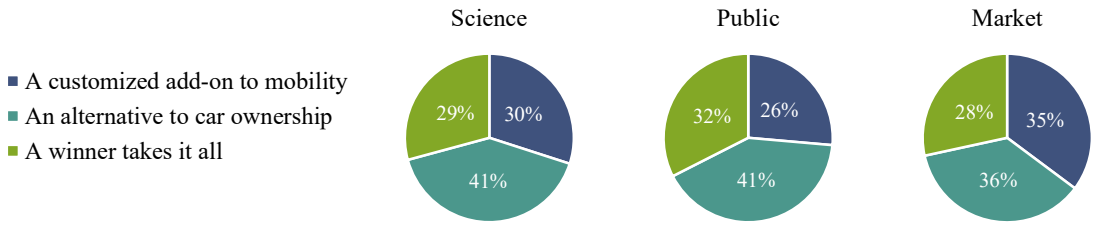

Figure 10 Support of the scenarios per actor group

To summarize the similarities and differences between the three scenarios, an overview is provided in table 6. Here the previous explained topics are shortly stated per scenario.

Table 6 Summary socio-technical scenarios

	Scenario 1 *A customized add-on to mobility*	**Scenario 2** *An alternative to car ownership*	**Scenario 3** *A winner takes it all*
Degree of transformation of the mobility system	There is little to no transformation of the mobility system, due to the amount of regulations.	There is a large transformation in the mobility system, as MaaS is fully integrated and accepted by the users.	There might be some transformation of the mobility system, but it can be both positive and negative.
Public and/or private influence	The private sector takes the lead, but the public authorities support them.	The public authorities and private sector are collaborating and have well-balance PPPs.	There is one private company having all control on the development of MaaS
Pathways	Transformation and reconfiguration	Transformation and de-alignment and re-alignment	Transformation and reconfiguration
Role national government	Regulates MaaS, based on the agreements made during the pilots.	Regulates and facilitates MaaS, based on the data flowing from the MaaS ecosystem.	Tries to limit the power of the MaaS provider and prevent a monopoly.
Role regional government	Focusses on the modality development and phasing out the car.	Adjusts their concession and permits to complement MaaS.	Tries to arrange the sharing mobility in such a way it does not benefit the MaaS provider.
Role MaaS provider	Connect with transport operators and provide an interface for users.	Attract new customers and seduce them, through direct contact. Increase the reliability of the platform.	Attract new customers and seduce them, through direct contact. Connect with transport operators
Role transport operator	Innovate and become more flexible.	Trust the MaaS provider and sell them the modalities available. Takes care of mobility.	Offers mobility for the user. Serve the MaaS provider.
Role users	Adapt MaaS and use as an addition to what they have been using before. Has an individualistic mindset.	Change travel behaviour and should always plan their trip in advance. Has a collective mindset.	Adapt MaaS and use as an addition to what they have been using before. Has an individualistic mindset.

5 Conclusion

Within this research, the expectations of the involved actors implementing MaaS in urban areas have been researched. Throughout an innovation process, expectations steer the development and thereby influence the innovation. Due to this role of expectations, it is important what expectations on a certain innovation are and whether they are aligned or not. Whenever expectations on a certain innovation are not aligned, they could cause delay. To be able to act upfront and create alignment within the expectations on MaaS, the divergence in the expectations of involved actors has been identified. These divergent expectations formed the base of the socio-technical scenarios on MaaS. The socio-technical scenarios made it possible to pour the expectations derived from the interviews into logical story lines and eventually made it possible to compare the expectations. Within this research the following research question has been answered:

What are the expectations of the actors involved in implementing Mobility as a Service in urban areas in the Netherlands, and what socio-technical scenarios can be derived from these expectations?

The interviews showed that the expectations regarding the development of MaaS, as well as the end goal of MaaS, are not unanimous. From the interviews with the different actor groups, science, public and market, divergent expectations were derived. Two main differences were argued throughout these divergent expectations, namely the degree of transformation compared to the current system and the public versus private influence on the MaaS development. Through these two main differences and other divergent expectations, three scenarios evolved. Within these three scenarios, the remaining expectations were subdivided and made the three scenarios complete.

The first scenario *a customized add-on to mobility* makes it possible for users to customize their mobility and is an addition to the mobility system, but it does not really optimize the system. By regulating MaaS within the pilots, and after the pilots leave the development to the market, there is more private influence. The second scenario *an alternative to car ownership* optimizes the total mobility system within cities, and public-private partnerships have established to achieve this in 2030. The last scenario *a winner takes it all* the private influence is the highest in this scenario, and there is some degree of optimization. As one MaaS provider rules the market, the public authorities try to prevent a monopoly.

From the expectations brought forward within the interviews, three possible scenarios and pathways have been indicated. All three scenarios differ in size, and speed, and are directed by the involved actors and their actions regarding the MaaS development. Under the right conditions, developments, and policies, MaaS could integrate in the mobility regime, and create a more optimized collective mobility system. This is just one of the scenarios that flowed from the expectations, *an alternative to car ownership*. The other two scenarios, *a customized add-on to mobility* and *a winner takes it all*, expect MaaS could not change the mobility regime but only act

as an add-on. These two scenarios argue the ecosystem of MaaS created during the pilots narrow further developments.

The roles and activities by involved actors mainly influence the development of MaaS in urban areas within the Netherlands. Some actors might have more influence than others, but each can steer the development in some way. When looking at the three scenarios, MaaS is present in all three of them. This means that all involved actors expect MaaS will be part of the mobility system of cities in 2030. From the three scenarios, the second scenario *an alternative to car ownership*, is most expected. When looking at the issues flowing from urbanization and policy objectives, like reducing car use, there could be said the second scenario is also the most desirable pathway.

To conclude, the constructed socio-technical scenarios and the implications regarding the roles adopted by the involved actors can be used to align expectations about MaaS. From the development of the socio-technical scenarios it appears that the future of MaaS is uncertain. MaaS could become an add-on to the mobility system, without changing the future mobility on a large scale. On the other hand, this researched shows MaaS also has the potential of substantially change the future urban mobility. This research can serve as input for debates regarding social and political decisions concerning the mobility system and the development of MaaS.

6 Discussion

6.1 Research quality and limitations

For this research, in total twenty-three interviews were conducted. Expectations were drawn from these interviews, and based on these expectations, scenarios could be constructed. However, compared to all involved stakeholders, this study only focused on the Randstad. The results from this study only apply to metropolitan areas and cannot be generalized to all urban areas.

When looking at the list of interviewees, all of them are directly involved in the field of mobility, or even directly in MaaS. As MaaS is a relatively new concept, it is most valuable to ask expectations from those totally understanding all the aspects of MaaS. As this interview mainly focused on three areas of the pilots, there was a risk of group blindness regarding the expectations on the future of MaaS. By interviewing actors not involved with the pilots, there has been worked around the possible group blindness from the pilots.

During the interviews, it turned out that it was difficult for some interviewees to really talk about their expectations, instead of talking about what they found desirable. Through constantly asking if what they said was also really something they expected, the real expectations came forward, instead of their intended purpose of MaaS. With the interview guide this has been covered as much as possible, but some interviewees were more comprehensive in their answer with some question than other interviewees. By using an interview guide, reproduction of this research is possible, and thereby the results of this research are externally valid.

As most of the interviews were in Dutch, quotes used in the scenario's descriptions had to be translated. This could mean there are subtle nuance differences between the actual quote and the translated quote. Eventually the meaning of the quote has not changed and are only used to strengthen the scenario description and give it narrative strength.

One large stakeholder group was not involved in the research, namely the users. As explained in the methods, expectations about the users were derived through the other stakeholders that were included. There has been chosen not to include the user directly, as the concepts is still unknown, and the potentials are difficult to imagine. Therefore, an explanation should be given on forehand, whereby the users that would be interviewed were biased by the explanation. By deriving what the interviewees expect what users want or need in the future regarding mobility is still useful.

6.2 Theoretical implications

Remmerswaal (2018) discussed the preferences on the supply side of MaaS in Nijmegen. From that research, three main preferences came forward: institutional barriers need to be removed, MaaS should correspondent with the municipality regulations, and collective data sharing is contributory. First, the removal of institutional barriers, also came forward in the expectations in this research. The current policies need to be rearranged to complement MaaS. This is the same for the infrastructure within cities. When looking at the traveller, it is expected their travel behaviour will change. These three institutional barriers are expected to be removed. The second preference, MaaS should correspondent with the municipality regulations, also came forward in this research. A municipality can strengthen the position of MaaS within a city through

regulations, such as inclusive mobility, price agreements concerning public transport, permits, parking tariffs, etcetera. Also, the data sharing, which is happening in the MaaS pilots, is of a collective nature. All parties share their data in the MaaS pilots, and all parties have access to the available data. So, the three main preferences identified by Remmerswaal (2018) concerning MaaS, are matched with the expectations argued in this research.

As described in the theory section, Smith, Sochor & Karlsson (2018) developed three scenarios, mainly focusing on the role of the public sector in MaaS. So, within this research is implied, all developments regarding MaaS in the Netherlands are done from a public point of view. The full market driven development from Smith, Sochor & Karlsson (2018) could be compared with *the winners takes it all* and *a customized add-on to mobility*. In both cases a private company becomes the MaaS provider and the public sector has influence through the public transport operators. The differences between the scenarios is the regulations and standardization that have been put in place by the public sector regarding MaaS during the pilots and in this way some public influence can be exerted. The publicly controlled development is not something that is expected. No one expects the public sector will become the MaaS provider within the Netherlands. Lastly the public-private development can be compared with *an alternative to car ownership*, where both public and private sector actively participate in the development of MaaS. Smith, Sochor & Karlsson (2018) argue the MaaS integrator role in this scenario will be adopted by the public sector, but this is not expected by the interviewees in this research. There is expected some of the activities from the MaaS integrator, for example the technical integration through the TOMP API, will be done in collaboration between the public and private sector, but the public sector has no active role as MaaS integrator.

6.3 Practical implications

From these results it can be indicated the role adopted by the involved actors have great influence on the development of MaaS, as also argued by Truffer, Voß & Konrad (2008). Only if an innovation can connect to ongoing dynamics in the regime- and landscape level, it has the potential to break through (Geels & Kemp, 2000). The role an involved actor adopts depends on their expectations about MaaS, and in this way they can influence the transition pathway of MaaS. Whenever expectations are aligned, the development of an innovation will continue with as little as possible delay. By exchanging expectations with stakeholders, desirable futures and in addition the conditions and adjustments needed to get there can be determined.

6.3.1 Implications for the government

Several implications can be made regarding the role the government adopts. Concerning the regulatory role, this mainly is about the extent to which regulations complement MaaS. The market forces can still take charge in innovation, but the regulations determine the playground. One topic came forward within all three scenarios: the car. By increasing the price of cars within cities specifically, with for example high parking costs, less parking areas, environmental zones, and facilitate an alternative, which could be MaaS, car ownership within cities specifically could potentially become less attractive.

When looking at the other modalities, sharing mobility and public transport, another implication came forward. During the interviews it appeared that some interviewees expect a change in what is called public transport in the future. According to them, sharing mobility should be public transport as well. The term public transport could be broadened and, in that way, sharing mobility could be seen more as an equal instead of a competitor

Related to this, the distribution of subsidies, and concession are expected to change as well. It is expected that the total subsidy budget will be spent more on specific improvements, instead of divided throughout modalities, like the car, and public transport. In this way, data can be used to improve the overall mobility system. In addition, change is expected in the concessions and permits regarding public transport and sharing mobility. According to the interviewees, pressure can be exerted through these permits to complement MaaS.

What happens in scenario 3 *a winner takes it all* is something that is being tried to prevent with the pilots. With the knowledge derived during the pilots, and the whole ecosystem originated from the pilots, the involved parties are one step ahead of their competitors. For all the parties, the available data about the travel behaviour, has huge value another party could never have in that moment of time.

It is most likely the first users of MaaS are people living in cities, as this is the focus of the pilots in the Randstad, and these might have intrinsic motivation regarding sustainability. To speed up the development other intrinsic motivations should be targeted as well, like money or time. Only by targeting the mass, MaaS has the potential to optimize the mobility system.

6.3.2 Implications for the market

Looking at the current market, and the changes in the market for the future of MaaS, some implications can be made. First there is the implementation barrier. By the development of the TOMP API, for standardization, smaller parties are involved. As these smaller parties still need to develop an API, it is a great opportunity for them. The larger companies which already serve the market, have spent money on their own API, and need to reinvest in the TOMP API. For the MaaS providers it would be valuable to connect with the larger sharing mobility operators as these already have the mass. So, integrating through an open standard is an easy way to connect, but present parties which already know some of the market might get lost.

Another implication for the market is the attraction of new customers. Within the market two parties can be distinguished, the transport operators, both public and sharing, and the MaaS providers. Both are currently responsible for their own customers. With the arrival of MaaS there might be a shift in marketing campaigns. This is something, MaaS providers and transport operators should make agreements about.

When looking at this last statement there is also competition. The MaaS provider can be seen as a competitor for transport operators, but without the connection of the transport operators a MaaS provider cannot offer multimodal trips. This interplay has influence on the eventual development of MaaS. An organizational model and business model need to be in place for both parties to coexist in the mobility system.

6.3.3 Implications for the user

Regarding the user in the MaaS ecosystem, some implications can be made. What if the MaaS ecosystem gets to a point where there can be steered on travellers their behaviour. Here the implication is whether the users are willing to be steered on their behaviour regarding the collective mobility system.

Before there can be steered on behaviour, it should be possible to predict or even know how people are planning to travel. By making use of this data, personal information is needed, involving privacy implications. At all times, the privacy law needs to be adhered to, and the actual person and personal information should not be able to extract from it.

6.4 Future research

Based on the limitations some future research suggestions can be done. Starting with one important group not included within this research, the user. Despite there has been chosen not to directly involve them in this research, it would be interesting to specifically research the expectations of the user regarding MaaS. This could be done during or after the MaaS pilots initiated within the Netherlands. At that moment people can experience the possibilities of MaaS and form expectations about the future of MaaS. As MaaS stands or falls with the acceptance of the user, this is a critical group.

Within the socio-technical scenario literature, a quantitative addition to the scenario construction is discussed by Geels, McMeekin & Pfluger (2020). By adding quantitative data to the scenario, like the reduce in CO_2, the change in air quality, the number around urbanization, an elaboration can be added. In this way it can be discussed if MaaS is able to achieve policy goals, which is one of the current expectations on MaaS.

As this study only focusses on MaaS in urban areas, a study focusing on the potentials of MaaS in rural areas and provinces could also be insightful. Within this study the rural areas came forward as a critical point, but as this was not included in this study there has not specifically been paid attention to this.

7 References

Alkemade, F., & Suurs, R. A. (2012). Patterns of expectations for emerging sustainable technologies. *Technological Forecasting and Social Change, 79*(3), 448-456. https://doi.org/10.1016/j.techfore.2011.08.014

Alonso-González, M. J., Hoogendoorn-Lanser, S., Van Oort, N., Cats, O., & Hoogedoorn, S. (2020). Drivers and barriers in adopting Mobility as a Service (MaaS) – A latent class cluster analysis of attitudes. *Transportation Research Part A: Policy and Practice, 132*, 378-401. https://doi.org/10.1016/j.tra.2019.11.022

Anderson, P., & Tushman, M. L. (1990). Technological discontinuities and dominant designs: A cyclical model of technological change. *Administrative science quarterly,* 604-633. https://doi.org/10.2307/2393511

Ayres, R. U. (1989). Industrial metabolism. *Technology and environment,* 23-49.

Bakker, S. (2014). Actor rationales in sustainability transitions – Interests and expectations regarding electric vehicle recharging. *Environmental Innovation of Societal Transitions*, *13*, 60-74. https://doi.org/10.1016/j.eist.2014.08.002

Banister, D. (2011). Cities, mobility and climate change. *Journal of Transport Geography, 19*(6), 1538-1546. https://doi.org/10.1016/j.jtrangeo.2011.03.009

Bazeley, P., & Jackson, K. (2013). *Qualitative data analysis with NVivo (2nd edition)*. London, United Kingdom: Sage Publications Limited.

Berkhout, F. (2006). Normative expectations in systems innovation. *Technology Analysis & Strategic Management, 18(*3-4), 299-311. https://doi.org/10.1080/09537320600777010

Borup, M., Brown, N., Konrad, K., & Van Lente, H. (2006). The sociology of expectations in science and technology. *Technology analysis & strategic management, 18*(3-4), 285-298. https://doi.org/10.1080/09537320600777002

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative research journal, 9*(2), 27-40. https://doi.org/10.3316/QRJ0902027

Brown, N., & Michael, M. (2003). A sociology of expectations: Retrospecting prospects and prospecting retrospects. *Technology analysis & strategic management, 15*(1), 3-18. https://doi.org/10.1080/0953732032000046024

Bryman, A. (2016). *Social research methods*. Oxford university press.

Caiati, V., Rasouli, S., & Timmermans, H. (2018). Subscription and bundling preferences for mobility as a service: a sequential portfolio choice experiment. *Transportation Systems in the Connected Era: Proceedings of the 23rd International Conference of Hong Kong Society for Transportation Studies (HKSTS),* 683–1391.

Centraal Bureau voor de Statistiek (CBS). (2017, February 22). *Nederlanders en hun auto: Een overzicht van de afgelopen tien jaar.* Retrieved from https://www.cbs.nl/nl-nl/achtergrond/2017/08/nederlanders-en-hun-auto

Centraal Bureau voor de Statistiek (CBS). (2019, January 2). *Bevolkingsgroei in 2018 vooral in de Randstad.* Retrieved December 4, 2019, from https://www.cbs.nl/nl-nl/nieuws/2019/01/bevolkingsgroei-in-2018-vooral-in-de-randstad

CIVITAS. (2016). *CIVITAS insight. Mobility-as-a-Service: A new transport model*. Retrieved from https://civitas.eu/sites/default/files/civitas_insight_18_mobility-as-a-service_a_new_transport_model.pdf

Coates, N. (1989). The globalization of the motor vehicle manufacturing industry. *Planning Review*, *17*(1), 34-39. https://doi.org/10.1108/eb054246

Coates, J. F., Mahaffie, J. B., & Hines, A. (1994). Technological forecasting: 1970-1993. *Technological forecasting and social change*, *47*, 23-33. https://doi.org/10.1016/0040-1625(94)90037-X

Cohen, B. (2006). Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Technology in society, 28*(1-2), 63-80. https://doi.org/10.1016/j.techsoc.2005.10.005

Corbin, J. & Strauss, A. (1990). Grounded Theory Research: Procedures, Canons, and Evaluative Criteria. *Qualitative Sociology 13*(1), 3-21. https://doi.org/10.1007/BF00988593

CROW. (2018). *Maatschappelijk trends in autodelen*. Retrieved from https://www.crow.nl/downloads/pdf/verkeer-en-vervoer/crow-kpvv/factsheet-autodelen-4-maatschappelijke-trends-en-a.aspx

Deloitte. (2017, January 23). The rise of mobility as a service. Reshaping how urbanites get around. *Deloitte Review*, (20). Retrieved from https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cb-ths-rise-of-mobility-as-a-service.pdf

Deloitte. (2019, October 9). *Mobility as a Service: de volgende revolutie in mobiliteit.* Retrieved December 4 2019, from https://www2.deloitte.com/nl/nl/pages/publieke-sector/articles/mobility-as-a-service-de-volgende-revolutie-in-mobiliteit.html

Eames, M., & McDowall, W. (2010). Sustainability, foresight and contested futures: exploring visions and pathways in the transition to a hydrogen economy. *Technology Analysis & Strategic Management, 22*(6), 671-692. https://doi.org/10.1080/09537325.2010.497255

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review, 14(*4), 532-550. https://doi.org/10.5465/amr.1989.4308385

Elzen, B., Geels, F. W., & Hofman, P. (2002). *Sociotechnical Scenarios (STSc): Development and evaluation of a new methodology to explore transitions towards a sustainable energy supply*. (CSTM Studies and Reports). Enschede: Center for Clean Technology and Environmental Policy.

Elzen, B., Geels, F. W., Hofman, P., & Green, K. (2004). Socio-technical scenarios as a tool for transition policy: An example from the traffic and transport domain. *System innovation and the transition to sustainability: Theory, evidence and policy*, 251-281. https://doi.org/10.4337/9781845423421.00024

Elzen, B., Hofman, P., & Geels, F. W. (2002). Sociotechnical Scenarios: A new methodology to explore technological transitions. *Enschede: University of Twente.*

Finger, M., Groenewegen, J., & Künneke, R. (2005). The quest for coherence between institutions and technologies in infrastructures. *Journal of Network industries,* (4), 227-259. https://doi.org/10.1177/178359170500600402

Flick, U. (2014). Mapping the field. *The SAGE handbook of qualitative data analysis*, 1-18.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy, 31*(8-9), 1257-1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research policy, 33*(6-7), 897-920. https://doi.org/10.1016/j.respol.2004.01.015

Geels, F. W. (2005). *Technological transitions and system innovations: a co-evolutionary and socio-technical analysis.* Cheltenham, United Kingdom: Edward Elgar Publishing.

Geels, F. W., & Raven, R. (2006). Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973–2003). *Technology Analysis & Strategic Management, 18*(3-4), 375-392. https://doi.org/10.1080/09537320600777143

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research policy, 36*(3), 399-417. https://doi.org/10.1016/j.respol.2007.01.003

Geels, F. W., & Schot, J. (2010). The Dynamics of Transitions: A Socio-Technical Perspective. *Transitions to Sustainable Development* (pp. 11-104). New York, USA: Taylor Francis.

Geels, F. W., & Smit, W. A. (2000). Failed technology futures: pitfalls and lessons from a historical survey. *Futures, 32*(9-10), 867-885. https://doi.org/10.1016/S0016-3287(00)00036-7

Geels, F. W., McMeekin, A., & Pfluger, B. (2020). Socio-technical scenarios as a methodological tool to explore social and political feasibility in low-carbon transitions: Bridging computer models and the multi-level perspective in UK electricity generation (2010–2050). *Technological Forecasting and Social Change*, *151*, 119–258. https://doi.org/10.1016/j.techfore.2018.04.001

Giesecke, R., Surakka, T., & Hakonen, M. (2016). Conceptualising mobility as a service. *2016 Eleventh International Conference on Ecological Vehicles and Renewable Energies (EVER)* (pp. 1-11). Monte Carlo Monaco: IEEE. https://doi.org/10.1109/EVER.2016.7476443

Glaser, B., & Strauss, A. (1967). *The Discovery of Grounded Theory: Strategies of Qualitative Research*. London, United Kingdom: AldineTransaction.

Goedopweg. (2019, July 25). *Goedopweg start samenwerking met Innovactory voor Mobility as a Service in Utrecht*. Retrieved 4 December 2019, from https://goedopweg.nl/nieuws/goedopweg-start-samenwerking-met-innovactory-voor-mobility-as-a-service-in-utrecht

Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The sharing economy: Why people participate in collaborative consumption. *Journal of the association for information science and technology, 67*(9)*,* 2047–2059. https://doi.org/10.1002/asi.23552

Hartikainen, A., Pitkänen, J.-P., Riihelä, A., Räsänen, J., Sacs, I., Sirkiä, A., & Uteng, A. (2019). *WHIMPACT: Insights from the world's first Mobility-as-a-Service (MaaS) system*. Retrieved from https://ramboll.com/-/media/files/rfi/publications/Ramboll_whimpact-2019

Hensher, D.A. (2017). Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: are they likely to change? *Transportation Research Part A: Policy Practice, 98*, 86–96. https://doi.org/10.1016/j.tra.2017.02.006

Hirschhorn, F., Paulsson, A., Sørensen, C. H., & Veeneman, W. (2019). Public transport regimes and mobility as a service: Governance approaches in Amsterdam, Birmingham, and Helsinki. *Transportation Research Part A: Policy and Practice*, *130*, 178-191. https://doi.org/10.1016/j.tra.2019.09.016

Ho, C. Q., Mulley, C., & Hensher, D. A. (2019). Public preferences for mobility as a service: Insights from stated preference surveys. *Transportation Research Part A: Policy and Practice*, *131*, 70-90. https://doi.org/10.1016/j.tra.2019.09.031

Ho, C.Q., Hensher, D.A., Mulley, C., & Wong, Y.Z. (2018). Potential uptake and willingness-to-pay for mobility as a service (MaaS): a stated choice study. *Transportation Research Part A: Policy Practice, 117*, 302–318. https://doi.org/10.1016/j.tra.2018.08.025

Hofman, P. S., Elzen, B. E., & Geels, F. W. (2004). Sociotechnical scenarios as a new policy tool to explore system innovations: Co-evolution of technology and society in the Netherland's electricity domain. *Innovation*, *6*(2), 344-360. https://doi.org/10.5172/impp.2004.6.2.344

Holmberg, P. E., Collado, M., Sarasini, S., & Williander, M. (2016). Mobility as a service: Describing the framework. 1-54.

Hoogma, R., Kemp, R., Schot, J., & Truffer, B. (2002). *Experimenting for sustainable transport future. The approach of strategic niche management.* New York, United States of America: Routledge.

Hughes, T. P. (1987). *The evolution of large technological systems.* The social construction of technological systems. New directions in the sociology and history of technology, 51-82.

Hughes, N. (2013). Towards improving the relevance of scenarios for public policy questions: a proposed methodological framework for policy relevant low carbon scenarios. *Technological Forecasting and Social Change*, *80*(4), 687-698. https://doi.org/10.1016/j.techfore.2012.07.009

IPSOS. (2019, October). *The future of mobility. Autonomous, electric and shared.* https://www.ipsos.com/sites/default/files/ct/publication/documents/2019-11/the-future-of-mobility-autonomous-electric-shared.pdf

ITS Australia. (2018). *Mobility as a Service in Australia: Customer insights and opportunities*. Retrieved from https://www.its-australia.com.au/maasreport/

Jittrapirom, P., Caiati, V., Feneri, A. M., Ebrahimigharehbaghi, S., Alonso González, M. J., & Narayan, J. (2017). Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges. *Urban Planning, 2*(2), 13-25. https://doi.org/10.17645/up.v2i2.931

Jittrapirom, P., Marchau, V., van der Heijden, R., & Meurs, H. (2018). Dynamic adaptive policymaking for implementing Mobility-as-a Service (MaaS). *Research in Transportation Business & Management, 27,* 46-55. https://doi.org/10.1016/j.rtbm.2018.07.001

Kamargianni, M., & Matyas, M. (2017). The Business Ecosystem of Mobility as a Service. 96th Transportation Research Board (TRB) Annual Meeting, Washington DC, 8-12 January 2017.

Kamargianni, M., Matyas, M., Li, W., & Muscat, J. (2018). *Londoners' attitudes towards car-ownership and Mobility-as-a-Service: Impact assessment and opportunities that lie ahead.* London, United Kingdom: University College London.

Kemp, R. (1994). Technology and the transition to environmental sustainability: the problem of technological regime shifts. *Futures, 26*(10), 1023-1046. https://doi.org/10.1016/0016-3287(94)90071-X

KiM (2018). *Mobility-as-a-Service and changes in travel preferences and travel behaviour: a literature review.*

Klepper, S. (1997). Industry life cycles. *Industrial and corporate change, 6*(1), 145-182. https://doi.org/10.1093/icc/6.1.145

Konrad, K. (2006). The social dynamics of expectations: the interaction of collective and actor-specific expectations on electronic commerce and interactive television. *Technology Analysis & Strategic Management, 18*(3-4), 429-444. https://doi.org/10.1080/09537320600777192

Lenz, B., & Fraedrich, E. (2016). New Mobility Concepts and Autonomous Driving: The Potential for Change. In *Autonomous Driving* (pp. 173–191). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-48847-8_9

Leonard-Barton, D. (1988). Implementation characteristics of organizational innovations: Limits and opportunities for management strategies. *Communication research*, *15*(5), 603-631. https://doi.org/10.1177/009365088015005006

Li, Y. & Voege, T. (2017) Mobility as a Service (MaaS): Challenges of Implementation and Policy Required. *Journal of Transportation Technologies, 7*, 95-106. https://doi.org/10.4236/jtts.2017.72007

Lyons, G., Hammond, P., & Mackay, K. (2019). The importance of user perspective in the evolution of MaaS. *Transportation Research Part A: Policy and Practice, 121*, 22–36. https://doi.org/10.1016/j.tra.2018.12.010

Lyons, G., Hammong, P., & Mackay, K., (2020). Reprint of: The importance of user perspective in the evolution of MaaS. *Transportation Research Part A: Policy and Practice*, *131*, 20-34. https://doi.org/10.1016/j.tra.2019.11.024

Manders, T. N., Wieczorek, A. J., & Verbong, G. P. J. (2018). Understanding smart mobility experiments in the Dutch automobility system: who is involved and what do they promise? *Futures, 96*, 90-103. https://doi.org/10.1016/j.futures.2017.12.003

Markard, J. (2011). Transformation of infrastructures: sector characteristics and implications for fundamental change. *Journal of Infrastructure Systems, 17*(3), 107-117. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000056

Markard, J., & Truffer, B. (2008). Technological innovation systems and the multi-level perspective: Towards an integrated framework. *Research policy, 37*(4), 596-615. https://doi.org/10.1016/j.respol.2008.01.004

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research policy, 41*(6), 955-967. https://doi.org/10.1016/j.respol.2012.02.013

Matyas, M. (2020). Opportunities and barriers to multimodal cities: lessons learned from in-depth interviews about attitudes towards mobility as a service. *European Transport Research Review*, *12*(1), 1–11. https://doi.org/10.1186/s12544-020-0395-z

Matyas, M., & Kamargianni, M. (2019). The potential of mobility as a service bundles as a mobility management tool. *Transportation*, *46*(5), 1951–1968. https://doi.org/10.1007/s11116-018-9913-4

McDowall, W. (2014). Exploring possible transition pathways for hydrogen energy: A hybrid approach using socio-technical scenarios and energy system modelling. *Futures, 63,* 1-14. https://doi.org/10.1016/j.futures.2014.07.004

McKinsey. (2019b, December 19). *The future of mobility is at our doorstep*. McKinsey & Company. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-mobility-is-at-our-doorstep#

Ministry of Infrastructure and Water Management (I&W). (2017a, June 12). *Improving utilization of infrastructure.* Retrieved 4 December 2019, from https://www.government.nl/topics/mobility-public-transport-and-road-safety/mobility/improving-utilization-of-infrastructure

Ministry of Infrastructure and Water Management (I&W). (2017b, September 19). *Increasing mobility in a more sustainable country.* Retrieved 20 July 2020, from https://www.government.nl/latest/news/2017/09/19/increasing-mobility-in-a-more-sustainable-country

Ministry of Infrastructure and Water Management (I&W). (2018, December 20). *Grote belangstelling marktpartijen voor deelname aan Mobility as a Service.* Retrieved December 4, 2019 from https://www.rijksoverheid.nl/actueel/nieuws/2018/12/20/grote-belangstelling-marktpartijen-voor-deelname-aan-mobility-as-a-service

Ministry of Infrastructure and Water Management (I&W). (2019a). *MaaS-pilots Projects - Optimising mobility*. Retrieved December 4, 2019 from https://dutchmobilityinnovations.com/attachment?file=7qczeMbWTcRrUzL2ExA8ug%3D%3D

Ministry of Infrastructure and Water Management (I&W). (2019b). *Schets mobiliteit naar 2040, veilig, robuust, duurzaam.* Retrieved July 20, 2020 from https://www.rijksoverheid.nl/documenten/rapporten/2019/06/07/schets-mobiliteit-naar-2040

Ministry of Infrastructure and Water Management (I&W). (2019c, July 11). *Kamerbrief over optimaliseren van het mobiliteitssysteem via MaaS.* Retrieved January 8, 2020 from https://www.rijksoverheid.nl/documenten/kamerstukken/2019/07/11/optimaliseren-van-het-mobiliteitssysteem-via-maas

Ministry of Infrastructure and Water Management (I&W). (2019d, November 19). *Mobility as a Service (MaaS): multimodaal reisadvies op maat*. Retrieved January 8, 2020 from https://www.rijksoverheid.nl/onderwerpen/mobiliteit-nu-en-in-de-toekomst/mobility-as-a-service-maas

Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard business review, 71*(3), 75-86.

MuConsult. (2017). *Mobility as a Service: Bouwstenen voor keuzen I&M.* Retrieved from https://dutchmobilityinnovations.com/spaces/1105/maas-programma/files/13401/muconsult-white-paper-mobility-as-a-service-pdf

Mukhtar-Landgren, D., Karlsson, M., Koglin, T., Kronsell, A., Lund, E., Sarasini, S., Sochor, J.L., & Wendle, B. (2016). *Institutional conditions for integrated mobility services (IMS): Towards a framework for analysis.* Retrieved from http://www.k2centrum.se/sites/default/files/institutional_conditions_for_integrated_mobility_services_ims_wp_2016-16_1.pdf

Nabielek, K., Kronberger-Nabielek, P., & Hamers, D. (2013). The rural-urban fringe in the Netherlands: recent developments and future challenges. *SPOOL, 1*(1). https://doi.org/10.7480/spool.2013.1.624

Nelson, R.R. (1995). Recent evolutionary theorizing about economic change. *Journal of Economic Literature*, *33*, 48–90.

Phillips, F. Y. (2001). *Market-oriented technology management: innovating for profit in entrepreneurial times*. Springer Science & Business Media.

Pistorius, C. W., & Utterback, J. M. (1997). Multi-mode interaction among technologies. *Research Policy*, *26*(1), 67-84. https://doi.org/10.1016/S0048-7333(96)00916-X

Planbureau voor de Leefomgeving (PBL). (2009). *Verstedelijking in de stadsrandzone: een verkenning van de ruimtelijke opgave*. Den Haag/Bilthoven: Planbureau voor de Leefomgeving.

Planbureau voor de Leefomgeving (PBL). (2016, May 5). *Cities in the Netherlands. Facts and figures on cities and urban areas.* Retrieved January 8, 2020 from https://www.rijksoverheid.nl/documenten/publicaties/2016/05/30/cities-in-the-netherlands

PWC. (2018). *Five trends transforming the Automotive Industry*. PricewaterhouseCoopers GmbH Wirtschaftsprüfungsgesellschaft. https://www.pwc.nl/nl/assets/documents/pwc-five-trends-transforming-the-automotive-industry.pdf

PWC. (2019). *Rapid urbanisation*. Retrieved December 4, 2019, from https://www.pwc.nl/en/topics/megatrends/urbanisation.html

Remmerswaal, J. (2018). *Stakeholder Preferences Regarding Mobility-as-a-Service: Practice and theory.* Retrieved from https://theses.ubn.ru.nl/handle/123456789/6794

Rip, A., & Kemp, R. (1998). Technological change. *Human choice and climate change, 2*(2), 327-399.

Rip, A., & Te Kulve, H. (2008). Constructive Technology assessment and socio-technical scenarios. In *The Yearbook of Nanotechnology in Society. Volume I: Presenting Futures.* (pp. 49-70). Springer Publishing.

RIVM. (2019). *Klimaatakkoord: effecten op veiligheid, gezondheid en natuur* (No. 0076). https://doi.org/10.21945/RIVM-2019-0076

Rosenberg, N. (1976a). On technological expectations. *The Economic Journal, 86*(343), 523-535. https://doi.org/10.2307/2230797

Rosenberg, N. (1976b). *Perspectives on technology.* CUP Archive.

Rosenkopf, L., & Tushman, M. L. (1994). Technology and organization. *Evolutionary dynamics of organizations*, *403*.

Sapio, B. (1995). SEARCH (Scenario evaluation and analysis through repeated cross impact handling): a new method for scenario analysis with an application to the Videotel service in Italy. *International Journal of Forecasting*, *11*(1), 113-131. https://doi.org/10.1016/0169-2070(94)02002-7

Sierpiński, G. (2011). Travel Behaviour and Alternative Modes of Transportation. *Communications in Computer and Information Science*, *239*, 86–93. https://doi.org/10.1007/978-3-642-24660-9_10

Simons, H. (2009). *Case study research in practice*. SAGE publications. https://dx.doi.org/10.4135/9781446268322

Smith, G., Sochor, J., & Karlsson, I. M. (2018). Mobility as a Service: Development scenarios and implications for public transport. *Research in Transportation Economics, 69*, 592-599. https://doi.org/10.1016/j.retrec.2018.04.001

Sochor, J., Strömberg, H., & Karlsson, I. C. M. (2015). Implementing mobility as a service: challenges in integrating user, commercial, and societal perspectives. *Transportation research record, 2536*(1), 1-9. https://doi.org/10.3141/2536-01

Statista. (2017). *Netherlands - urbanization 2017*. Retrieved December 4, 2019, from https://www.statista.com/statistics/276724/urbanization-in-the-netherlands/

Suarez, F. F., & Oliva, R. (2005). Environmental change and organizational transformation. *Industrial and Corporate Change*, *14*(6), 1017–1041. https://doi.org/10.1093/icc/dth078

Truffer, B., Voß, J. P., & Konrad, K. (2008). Mapping expectations for system transformations: Lessons from Sustainability Foresight in German utility sectors. *Technological Forecasting and Social Change, 75*(9), 1360-1372. https://doi.org/10.1016/j.techfore.2008.04.001

United Nations (UN), (2018). *68% of the world population projected to live in urban areas by 2050, says UN.* Retrieved 14 November 2019, from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.htmlhttps://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

Utriainen, R., & Pöllänen, M. (2018). Review on mobility as a service in scientific publications. *Research in Transportation Business & Management, 27*, 15–23. https://doi.org/10.1016/j.rtbm.2018.10.005

Van Lente, H. (1993). *Promising technology. The Dynamics of Expectations in Technological Developments.* Delft, The Netherlands: Eburon.

Van Lente, H., & Bakker, S. (2010). Competing expectations: the case of hydrogen storage technologies. *Technology Analysis & Strategic Management, 22*(6), 693-709. https://doi.org/10.1080/09537325.2010.496283

Van Lente, H., & Rip, A. (1998). Expectations in Technological Developments: An Example of Prospective Structures to be Filled in by Agency. *Getting New Technologies Together. Studies in Making Sociotechnical Order* (203-231). Berlin, Germany: Walter De Gruyter.

Weber, K. M. (2003). Transforming large socio-technical systems towards sustainability: on the role of users and future visions for the uptake of city logistics and combined heat and power generation. *Innovation: The European Journal of Social Science Research, 16*(2), 155-175. https://doi.org/10.1080/13511610304522

Wegener, M. (2013). The future of mobility in cities: Challenges for urban modelling. *Transport Policy, 29*, 275-282. https://doi.org/10.1016/j.tranpol.2012.07.004

Zijlstra, T., Durand, A., Hoogendoorn-Lanser, S., & Harms, L. (2019). *Kansrijke groepen voor mobility-as-a-service.*

Appendix I – The core characteristics of MaaS

Table 7 Core characteristics of MaaS (Jittrapirom et al., 2018)

Core Characteristic	Description
1. Integration of transport modes	A goal of MaaS schemes is to encourage the use of public transport services, by bringing together multi-modal transportation and allowing the users to choose and facilitating them in their intermodal trips. Following transport modes may be included: public transport, taxi, car-sharing, ride-sharing, bike-sharing, car-rental, on-demand bus services. Envisioning a service beyond the urban boundaries, it will embrace also long-distance buses and trains, flights, and ferries.
2. Tariff option	MaaS platform offers users two types of tariffs in accessing its mobility services: "mobility package" and "pay-as-you-go". The package offers bundles of various transport modes and includes a certain amount of km/minutes/points that can be utilized in exchange for a monthly payment. The pay-as-you-go charges users according to the effective use of the service.
3. One platform	MaaS relies on a digital platform (mobile app or web page) through which the end-users can access to all the necessary services for their trips: trip planning, booking, ticketing, payment, and real-time information. Users might also access to other useful services, such as weather forecasting, synchronization with personal activity calendar, travel history report, invoicing, and feedback.
4. Multiple actors	MaaS ecosystem is built on interactions between different groups of actors through a digital platform: demanders of mobility (e.g. private customer or business customer), a supplier of transport services (e.g. public or private) and platform owners (e.g. third party, PT provider, authority). Other actors can also cooperate to enable the functioning of the service and improve its efficiency: local authorities, payment clearing, telecommunication and data management companies.
5. Use of technologies	Different technologies are combined to enable MaaS: devices, such as mobile computers and smartphones; a reliable mobile internet network (WiFi, 3G, 4G, LTE); GPS; e-ticketing and e-payment system; database management system and integrated infrastructure of technologies (i.e. IoT).
6. Demand orientation	MaaS is a user-centric paradigm. It seeks to offer a transport solution that is best from customer's perspective to be made via multimodal trip planning feature and inclusion of demand-responsive services, such as taxi.
7. Registration requirement	The end-user is required to join the platform to access available services. An account can be valid for a single individual or, in certain cases, an entire household. The subscription not only facilitates the use of the services but also enables the service personalisation.
8. Personalization	Personalisation ensures end users' requirements and expectations are met more effectively and efficiently by considering the uniqueness of each customer. The system provides the end-user with specific recommendations and tailor-made solutions on the basis of her/his profile, expressed preferences, and past behaviors (e.g. travel history). Additionally, they may connect their social network profiles with their MaaS account.
9. Customization	Customisation enables end users to modify the offered service option in according to their preferences. This can increase MaaS' attractiveness among travelers and its customers' satisfaction and loyalty. They may freely compose a specified chained trip or build their mobility package with a different volume of usage of certain transport modes to better achieve their preferred travel experiences.

Appendix II – Interview guide

1. Kan je iets over jezelf vertellen?
    - Wie ben je?
    - Wat doe je?
        - Welk bedrijf?
        - Welke functie?
2. Op welke manier bent u betrokken bij MaaS?
3. Wat is MaaS voor u?
    - Waaraan moet MaaS voldoen qua componenten?
    - Hoe functioneert MaaS? Wat zijn de minimale eisen voor MaaS? (persoonlijke voorkeuren, plannen, boeken, reizen, ondersteunen, aanpassen, betalen)
    - Welke modaliteiten binnen MaaS?
        - Wat zal de basis transportwijze zijn binnen MaaS?
4. Wat is het doel van MaaS?
    - Welk probleem kan MaaS volgens jou oplossen?
    - Wat zijn de kansen die MaaS kan bieden?
    - Op welke grote trends zou MaaS een bijdrage kunnen hebben? Of een oplossing kunnen zijn?
5. Hoe zal het transportsysteem/vervoerssysteem eruit zijn rondom MaaS?
    - Wat zal er anders zijn dan in dit huidige transportsysteem?
    - Wat is de rol van het openbaar vervoer?
    - Hoe krijgen eigen modaliteiten een plek in het ecosysteem?
    - Wat verwacht je van de wet en regelgeving omtrent MaaS?
6. Welke partijen zijn er nodig om MaaS aan te bieden?
    - Wie heeft welke taak binnen het MaaS ecosysteem?
    - Hoe wordt er geld verdiend binnen het nieuwe MaaS ecosysteem?
7. Wie is de verwachte gebruiker voor MaaS?
    - Voor welke doeleinden zullen zij gebruik maken van MaaS?
    - Wat zijn de voordelen voor de gebruikers?
    - In hoeverre verwacht je dat MaaS geaccepteerd zal worden? Of de nieuwe standaard zal worden?
8. Welke strategie is nodig gebruikt om dit doel te behalen?
    - Wat zijn belangrijke stappen?
    - Welke maatregelen maken deze ontwikkelstappen mogelijk?
    - Welke tijdsindicatie verwacht je voor deze ontwikkeling?
9. Welke uitdagingen zitten er in de implementatie van MaaS?
10. Hoe ziet uw ideale toekomst eruit omtrent mobiliteit?
11. Wat zijn uw plannen voor de toekomst?

Appendix III – Detailed interview information

Table 8 Detailed interview information

	Interviewee	Date	F2F or Telephone	Length	Language
1	Planbureau voor de Leefomgeving	18/02/2020	Face 2 Face	0:45	Dutch
2	TU Delft	05/03/2020	Face 2 Face	1:10	Dutch
3	Radboud University	25/03/2020	Telephone	0:35	Dutch
4	TU Eindhoven	26/02/2020	Face 2 Face	1:00	English
5	TNO	25/03/2020	Telephone	1:00	Dutch
6	Ministry of Infrastructure and Water Management	06/03/2020	Face 2 Face	0:50	Dutch
7	Gemeente Amsterdam	12/03/2020	Face 2 Face	0:40	Dutch
8	Projectbureau Zuidas	02/03/2020	Face 2 Face	1:05	Dutch
9	Gemeente Rotterdam	27/02/2020	Face 2 Face	1:05	Dutch
10	De Verkeersonderneming	12/03/2020	Telephone	0:50	Dutch
11	Gemeente Utrecht	27/03/2020	Telephone	0:50	Dutch
12	Goed op Weg	05/03/2020	Face 2 Face	0:55	Dutch
13	Amaze	10/03/2020	Face 2 Face	0:50	Dutch
14	MOVE	11/03/2020	Face 2 Face	0:55	Dutch
15	Gaiyo	04/03/2020	Face 2 Face	1:20	Dutch
16	Hely	16/03/2020	Telephone	0:50	Dutch
17	GVB	20/03/2020	Telephone	0:40	Dutch
18	RET	27/03/2020	Telephone	0:45	Dutch
19	Qbuzz	09/03/2020	Face 2 Face	1:00	Dutch
20	NS	19/03/2020	Telephone	0:55	Dutch
21	Donkey Republic	11/03/2020	Telephone	0:35	Dutch
22	Greenwheels	04/03/2020	Face 2 Face	1:10	Dutch
23	Felyx	12/03/2020	Face 2 Face	0:25	Dutch

Appendix IV – Nodes structure of the expectations about MaaS

Table 9 Nodes structure of the expectations derived through the interviews

Name	Files	References
Expectations	**23**	**2334**
Challenges arising	**22**	**86**
Risk of market forces	13	24
Image of the car	15	24
MaaS should not be a goal	4	5
Technological development could be an issue	1	1
Too much focus on technology user forgotten	9	14
User acceptance is a challenge	6	7
Visibility of MaaS	8	11
Changes of cities	**23**	**122**
Car free city centres	10	17
Increase liveability within the cities	21	53
Keep cities accessible	8	10
MaaS will become the standard way of travelling within cities	15	19
MaaS will only be an addition to mobility within cities	8	9
Pollution of public space by vehicles	1	1
Still cars within the city (not specified centre)	12	13
Characteristics of MaaS	**23**	**87**
MaaS is a solution for a non-existing problem	7	16
MaaS is an app	17	26
There will only be one large platform	4	7
There will be several platforms	17	38
Effect on mobility	**23**	**352**
Access to mobility	6	9
Change travel behavior with MaaS	14	29
Combine different modalities	21	49
Could reduce car ownership	19	41
Could reduce congestion	12	18
Mass needed to make impact	6	7
More car use	6	7
No short-term effect	3	4
Optimize the mobility system	22	65
Public transport should innovate	14	21
Redesign of the urban infrastructure	18	55
Reduce car use	16	33
Reduce CO_2 emissions Zero emissions	3	3
Total mobility spending's stay the same	5	7

Use of more passive mobility services	3	4
Mobility system	**23**	**204**
MaaS can also be used in rural areas	9	18
MaaS can only be used in urban areas	13	24
MaaS on demand	5	6
MaaS supports cross-border mobility	13	27
Mobility needs should decrease	2	2
Mobility will become cheaper	16	22
Mobility will become more expensive	5	11
Moment to change behaviour change in life	5	8
More sharing mobility	17	30
The more alternatives, the better MaaS	17	56
Modalities development	**23**	**231**
First and last mile solutions important	10	11
MaaS could reduce owned modalities	19	42
MaaS includes all possible modalities	16	19
MaaS includes public transport	21	32
MaaS includes sharing mobility	20	28
MaaS includes taxi	8	10
MaaS includes the own modality	20	42
Public transport cannot handle pressure from MaaS	10	11
Public transport will be the backbone of MaaS	18	30
The car will be the base of MaaS	5	6
New business models for MaaS	**23**	**207**
Curated system approach	11	34
MaaS only works as ecosystem	10	23
No business case	12	23
Detached system approach	10	19
Public-private partnerships are needed for MaaS	18	52
Revenue model	*19*	*56*
Bundles	11	18
Combination of different business models	1	1
Pay per use	13	17
Reward model	4	5
Sell data	3	3
Through extra services	4	7
Through promotions	4	5
Other trends	**23**	**163**
Able to give proactive travel advice	13	43
Airplane can be part of MaaS	5	6
Autonomous vehicle can be addition to MaaS	9	15
Autonomous vehicle is no addition to MaaS	2	2

Development of new mobility forms	13	25
Digitization	11	20
From ownership to access	3	5
Gamification	2	2
MaaS can play a role in urbanization	9	12
MaaS could contribute to sustainability	10	14
More electrical vehicles	9	14
Ride along and share modalities with other people	4	5
Pilots	**10**	**17**
A few succeed	2	3
None succeed	3	3
Scale up MaaS after pilots	7	11
Regulatory Framework	**23**	**191**
Change concession demand	9	17
Current policy changes are way to slow	8	9
EU wide standard needed for MaaS	6	8
External stimulus for MaaS by government	13	28
Financial support of the government	4	5
New regulations	8	12
Oblige the TOMP API	18	37
Open data policy	15	32
Rearrange the subsidies	9	15
Steer on behaviour for collective goals	16	28
Roles of involved actors	**23**	**215**
Government	*22*	*89*
Create a level playing field	14	20
Facilitating role	4	6
Financially support	7	12
Look at active market parties	3	8
MaaS not efficient way to achieve policy goals	1	2
Manage the data	4	6
Unclear role government	1	1
Municipality	12	34
Facilitate	8	18
Include everyone	2	3
Keep control	2	3
Let people experience	7	7
Rules from city not always complement users' needs	1	1
Market	*21*	*126*
Market should take the lead	7	10
MaaS provider	18	73
Attract new customers (through marketing campaigns)	3	5

Connect mobility providers	14	25
Could have both the app and the platform	5	5
Need for price agreements	8	17
Not always visible for user	2	2
Offer total package to customer	5	7
Should be an independent party	6	12
Mobility provider	18	43
Attract new customers	3	4
MaaS is a competitor for mobility providers	7	12
Mobility provider becomes MaaS provider	7	9
Mobility provider under the MaaS provider	6	7
Not giving away margin to MaaS provider	3	6
Public transport becomes MaaS provider	3	5
Strategy towards MaaS	**20**	**62**
Expand existing apps	2	2
Experimenting	16	32
Just do it	3	8
Learning	11	18
Researching	2	2
Users of MaaS	**23**	**397**
Incentivize user	6	9
Insight in mobility impact	11	26
Insight in mobility options	17	37
More customized mobility	21	71
More inclusive mobility	15	25
Reliability of MaaS is needed, but not yet there	10	13
Seduce user	14	21
Unburdening of the user	16	28
Users should always plan their trips	2	2
Kind of trips	*23*	*75*
MaaS will be used for infrequent trips	14	19
MaaS will be used for routine	16	18
MaaS will be used for short trips	14	14
MaaS will be used to plan your day	7	12
MaaS will not be used for routine	7	9
MaaS will not be used for short trips	3	3
Target group	*23*	*90*
Business traveller	13	23
Early adopters are the first	12	17
Eventually everyone potential user	12	13
MaaS not an addition for everyone	3	4
Not business traveller	1	1

Potential user already travels multimodal	14	21
Potential user owns a car	8	11

Appendix V – Expectations distributed over the scenarios

Table 10 Distribution of expectations about MaaS per scenario

Name	Files	References	1 A customized add-on to mobility	2 An alternative to car ownership	3 A winner takes it all
Expectations	**23**	**2334**			
Challenges	**22**	**86**			
Risk of market forces	13	24			×
Image of the car	15	24		×	
MaaS should not be a goal	4	5		×	
Technological development could be an issue	1	1		×	
Too much focus on technology user forgotten	9	14	×		
User acceptance is a challenge	6	7	×	×	
Visibility of MaaS	8	11	×		×
Changes of cities	**23**	**122**			
Car free city centres	10	17		×	
Increase liveability within the cities	21	53		×	
Keep cities accessible	8	10		×	
MaaS will become the standard way of travelling within cities	15	19		×	
MaaS will only be an addition to mobility within cities	8	9	×		×
Pollution of public space by vehicles	1	1	×		×
Still cars within the city (not specified centre)	12	13	×		×
Characteristics of MaaS	**23**	**87**			
MaaS is a solution for a non-existing problem	7	16	×		
MaaS is an app	17	26	×	×	×
There will only be one large platform	4	7			×
There will be several platforms	17	38	×	×	
Effect on mobility	**23**	**352**			
Access to mobility	6	9	×	×	
Change travel behaviour with MaaS	14	29		×	

Combine different modalities	21	49	×	×	×
Could reduce car ownership	19	41		×	
Could reduce congestion	12	18		×	
Mass needed to make impact	6	7		×	
More car use	6	7	×		×
No short-term effect	3	4	×		
Optimize the mobility system	22	65	×	×	
Public transport should innovate	14	21	×	×	
Redesign of the urban infrastructure	18	55		×	
Reduce car use	16	33		×	
Reduce CO_2 emissions Zero emissions	3	3		×	
Total mobility spending's stay the same	5	7	×		
Use of more passive mobility services	3	4	×		×
Mobility system	**23**	**204**			
MaaS can also be used in rural areas	9	18		×	
MaaS can only be used in urban areas	13	24	×		×
MaaS on demand	5	6		×	
MaaS supports cross-border mobility	13	27		×	×
Mobility needs should decrease	2	2		×	
Mobility will become cheaper	16	22	×		
Mobility will become more expensive	5	11		×	×
Moment to change behaviour change in life	5	8	×	×	
More sharing mobility	17	30	×	×	×
The more alternatives, the better MaaS	17	56	×	×	
Modalities development	**23**	**231**			
First and last mile solutions important	10	11		×	
MaaS could reduce owned modalities	19	42		×	
MaaS includes all possible modalities	16	19	×	×	×
MaaS includes public transport	21	32	×	×	×
MaaS includes sharing mobility	20	28	×	×	×
MaaS includes taxi	8	10	×	×	×
MaaS includes the own modality	20	42	×	×	×
Public transport will be the backbone of MaaS	18	30		×	×
Public transport can't handle pressure from MaaS	10	11			×
The car will be the base of MaaS	5	6	×		
New business models	**23**	**207**			
Curated system approach	11	34	×	×	
MaaS only works as ecosystem	10	23		×	
No business case	12	23	×		
Detached system approach	10	19	×		×
Public-private partnerships are needed for MaaS	18	52	×	×	

Revenue model	*19*	*56*			
Bundles	11	18		×	×
Combination of different business models	1	1		×	×
Pay per use	13	17	×	×	×
Reward model	4	5		×	
Sell data	3	3		×	×
Through extra services	4	7	×	×	
Through promotions	4	5	×		×
Other trends	**23**	**163**			
Able to give proactive travel advice	13	43		×	
Airplane can be part of MaaS	5	6		×	
Autonomous vehicle can be addition to MaaS	9	15	×	×	
Autonomous vehicle is no addition to MaaS	2	2			×
Development of new mobility forms	13	25	×	×	×
Digitization	11	20	×	×	×
From ownership to access	3	5		×	
Gamification	2	2		×	
MaaS can play a role in urbanization	9	12		×	
MaaS could contribute to sustainability	10	14		×	
More electrical vehicles	9	14	×	×	
Ride along and share modalities with other people	4	5		×	
Pilots	**10**	**17**			
A few succeed	2	3	×	×	
None succeed	3	3			×
Scale up MaaS after pilots	7	11		×	
Regulatory Framework	**23**	**191**			
Change concession demand	9	17	×	×	
Current policy changes are way to slow	8	9			×
EU wide standard needed for MaaS	6	8		×	
External stimulus for MaaS by government	13	28		×	
Financial support of the government	4	5		×	
New regulations	8	12	×	×	
Oblige the TOMP API	18	37	×	×	
Open data policy	15	32	×	×	
Rearrange the subsidies	9	15		×	
Steer on behaviour for collective goals	16	28		×	
Roles of involved actors	**23**	**250**			
Government	*22*	*89*			
Create a level playing field	14	20	×	×	
Facilitating role	4	6		×	
Financially support	7	12		×	

Look at active market parties	3	8	×		
MaaS not efficient way to achieve policy goals	1	2	×		×
Manage the data	4	6	×	×	
Unclear role government	1	1			×
Municipality	12	34			
Facilitate	8	18	×	×	
Include everyone	2	3		×	
Keep control	2	3		×	
Let people experience	7	7		×	
Rules from city not always complement users' needs	1	1	×		
Market	*21*	*126*			
Market should take the lead	7	10	×		×
MaaS provider	18	73			
Attract new customers (through marketing campaigns)	3	5		×	
Connect mobility providers	14	25	×	×	×
Could have both the app and the platform	5	5	×	×	×
Need for price agreements	8	17	×	×	
Not always visible for user	2	2	×		×
Offer total package to customer	5	7	×	×	
Should be an independent party	6	12	×	×	×
Mobility provider	18	43			
Attract new customers	3	4	×	×	×
MaaS is a competitor for mobility providers	7	12	×		×
Mobility provider becomes MaaS provider	7	9	×	×	
Mobility provider under the MaaS provider	6	7	×		×
Not giving away margin to MaaS provider	3	6	×		×
Public transport becomes MaaS provider	3	5		×	
Strategy	**20**	**62**			
Expand existing apps	2	2	×		
Experimenting	16	32	×	×	
Just do it	3	8		×	
Learning	11	18	×		
Researching	2	2	×		
User	**23**	**397**			
Incentivize user	6	9		×	
Insight in mobility impact	11	26	×	×	
Insight in mobility options	17	37	×	×	×
More customized mobility	21	71	×	×	×
More inclusive mobility	15	25		×	
Reliability of MaaS is needed, but not yet there	10	13	×	×	
Seduce user	14	21		×	

Unburdening of the user	16	28		×	
Users should always plan their trips	2	2		×	
Kind of trips	*23*	*75*			
MaaS will be used for infrequent trips	14	19		×	×
MaaS will be used for routine	16	18		×	×
MaaS will be used for short trips	14	14	×		×
MaaS will be used to plan your day	7	12		×	
MaaS will not be used for routine	7	9	×		
MaaS will not be used for short trips	3	3		×	
Target group	*23*	*90*			
Business traveller	13	23	×		
Early adopters are the first	12	17	×	×	×
Eventually everyone potential user	12	13		×	
MaaS not an addition for everyone	3	4	×		×
Not business traveller	1	1	×		
Potential user already travels multimodal	14	21	×		×
Potential user owns a car	8	11		×	