Evaluating Barriers in the Business Ecosystem of European MaaS Providers: An Actor Network Approach

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Abstract

As new Mobility as a Service (MaaS) platforms are being established in Europe, researchers and practitioners are looking for evidence of the barriers that the MaaS providers are experiencing in their evolving business ecosystem. By constructing an actor network, this thesis conceptualises the MaaS business ecosystem using a Systematic Literature Review (SLR) combined with Actor Network Theory (ANT). This actor network and the identified MaaS business ecosystem barriers are then used for Multiple Case Study Research, interviewing 18 European MaaS experts. First, the within-case analysis reveals how MaaS providers problematise, interest, enrol and mobilise their business ecosystem. Then, the cross-case analysis evaluates the findings of the actor networks by outlining and amending key barriers in the areas of (1) technology and data, (2) social and cultural, and (3) policy and regulation. The key patterns of barriers are then used to discuss nine observations that emerged from the field. These findings are then synthesised to derive success factors that help overcome the barriers. All findings are summarised in the final Cases, Actor Networks, Barriers, and Success Factors (CABS) framework. This CABS framework supports researchers and practitioners in formulating policies, leveraging best practices, or conducting further research on the development of MaaS.

Declaration of Original Content

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

Any views expressed in the thesis are those of the author and in no way represent those of the University.

Julian Gebhart

Signed: [redacted]_______________

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Contents

Abbreviations

ANT	-	Actor Network Theory
API	-	Application Programming Interface
B2B	-	Business To Business
CABS	-	Cases, Actor-Networks, Barriers, Success Factors
DANA	-	Dynamic Actor Network Analysis
GDPR	-	General Data Protection Regulation
ICT	-	Information and Communication Technologies
IoT	-	Internet of Things
IS	-	Information Systems
ITS	-	Intelligent Transportation Systems
KPI	-	Key Performance Indicator
MaaS	-	Mobility as a Service
MSP	-	Mobility Service Provider
NFC	-	Near-Field Communication
OEM	-	Original Equipment Manufacturer
OPP	-	Obligatory Passage Point
PPP	-	Public Private Partnership
PPPP	-	Public Private People Partnership
PSP	-	Payment Service Provider
SLA	-	Service Level Agreement
SLR	-	Systematic Literature Review
SME	-	Subject Matter Expert
SOA	-	Service-Oriented Architecture
STS	-	Socio-Technical Systems
XaaS	-	Everything as a Service

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1 Introduction

We now live in a world where we can consume almost anything at the touch of a button - be it music, movies, or buying products online. Many digital services are available and accessible in seconds via the internet. However, mobility is reaching its limits, particularly in cities, requiring us to find intelligent solutions for future mobility. In cities, the possibilities for consuming mobility are almost endless. Nevertheless, quickly finding the best and most environmentally friendly mobility offer is impossible.

Here, the concept of Mobility as a Service (MaaS) can help by bundling all mobility options into one service and making it available to everyone. But why is this concept not there yet, and what are the barriers to building such MaaS platforms? This research aims to shed light on state-of-the-art MaaS platforms, investigating the barriers providers face.

The first chapter of this thesis introduces the research background (*see* Section 1.1) and explains the research problem (*see* Section 1.2). Then, a thesis statement is formulated based on the identified research problem (*see* Section 1.3). To address this research problem, the research aim, questions, and objectives are declared (*see* Section 1.4). After that, the thesis scope defines the limits of the thesis to achieve the research objectives presented earlier (*see* Section *1.5).* Finally, the structure of the thesis is outlined (*see* Section 1.6).

1.1 Research Background

This section describes the research background of this thesis. First, motivational factors are introduced. Second, the relevance of this research topic is highlighted. Finally, initial gaps from the literature are presented, which help to formulate the business and research problem in the following section.

In the transportation industry, digitalisation enables new concepts like MaaS. Since the initial introduction of MaaS by Hietanen (2014), mobility services are gaining traction and becoming relevant for both enterprises and consumers. In this context, companies are searching for information and studies on how business ecosystems like the MaaS business ecosystem are developing. At the same time, in academia, researchers started to formulate and conceptualise MaaS and its business ecosystem by conducting studies and analysing the market. By looking at the academic literature, it is observable that the rising importance of establishing and consuming mobility services is being recognised and addressed by academic papers in the field. This importance and relevance are expressed in the literature through the following three key factors:

The Rising Need for New Mobility Concepts

In the literature, it is considered common sense that new, more sustainable daily mobility solutions are needed. Here, El Zarwi et al. (2017); Utriainen and Pöllänen (2018) observe that increased urbanisation followed by a growing amount of traffic results in environmental discussions and a need for innovative solutions. In addition, Araghia et al. (2020) highlight that 70% of the world's population will live in urban areas by the year 2050. This means that urban areas, including individual urban mobility demands, will grow. Here, efficient, and innovative ways are needed to cope with these increasing demands of urban mobility.

In addition, Carbon Dioxide (CO_2) emissions are increasing due to the urbanisation and growing mobility needs of people. Friedlingstein et al. (2020) recognise and present in their annual global carbon budget paper of 2020 that worldwide CO_2 emissions in 2010-2019 increased yearly by +0.9%. Globalisation, local workforce needs, and significant differences in living costs and salaries across urban, regional, and national borders drive this need for new mobility concepts (Giesecke et al., 2016). This puts pressure to find new ways to decrease greenhouse gas emissions by using technology and building new mobility solutions.

Further, a growth in environmental awareness can be observed, challenging the traditional notion of car ownership (Arias-Molinares & García-Palomares, 2020). The study of Liljamo et al. (2021) revealed that mobility services could decrease people's willingness to own a car significantly if the services cover the individual mobility needs of people and provide economic benefits. Therefore, offering mobility services will ultimately result in a changed relationship between society and transportation options.

Everything as a Service (XaaS) and Integrated Mobility Services with MaaS

In parallel, exponential technologies drive the experiences and deliver innovative solutions in our daily lives. Through modern cloud architectures and connectivity enabled by smartphones, the way how services are being consumed is changing. Previously, services were only available on traditional desktop PCs, connected to application servers hosting applications on-premises. Moreover, most services were consumed in an analogue way, meaning someone had to go somewhere physically to consume a service. Today, digitalisation enables building platforms or marketplaces to consume Everything-as-a-Service (XaaS). One recent disruptive example happened in the music and movie industry.

Previously, music or movies had to be acquired in an analogue way by buying or renting CDs and DVDs locally. These days, Netflix and Spotify provide digitised services to consume music and movies online. Offering such a service platform revolutionised how music or movies are consumed. The same shift is happening slowly in the transportation industry using new Information and Communication Technologies (ICT). Here, MaaS promises to be a key concept to enable individual mobility more sustainably. MaaS enables a shift from owning private vehicles to a new integrated mobility services marketplace (Pangbourne et al., 2018). It can be seen as a concept, business model, or enabler that allows the end-user to consume different transportation modes as a service by combining them through a single tailored interface (Jittrapirom et al., 2017). Thus, MaaS places the user's needs at the centre of the transport system (Utriainen & Pöllänen, 2018).

Kamargianni and Matyas (2017) describe and envision in their paper how the current situation in the transportation industry will change for urban and intercity trips by adopting a MaaS model offered by a MaaS provider. This paradigm shift has been adopted and visualised in Figure 1.

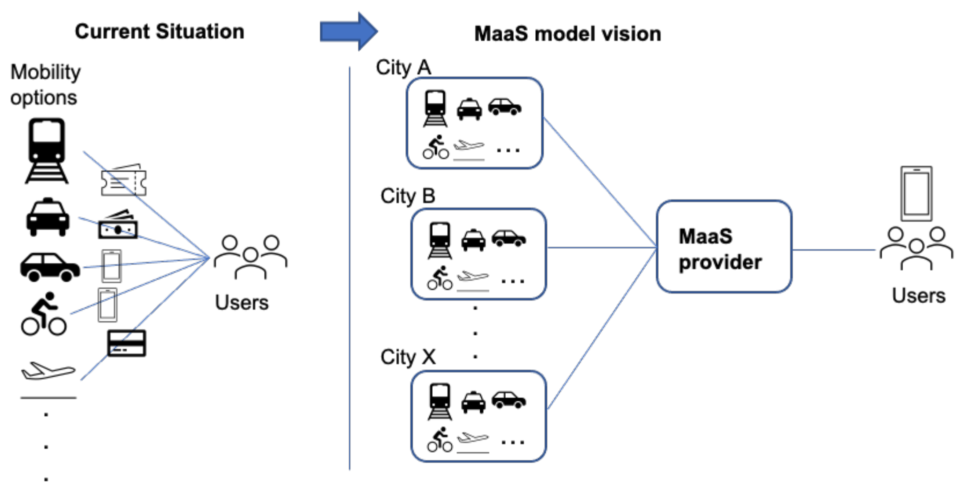


Figure 1. Paradigm Shift through MaaS in the Transportation Industry adopted by Kamargianni and Matyas (2017)

When the whole spectrum of mobility options becomes available via an integrated service ecosystem, there will be a shift towards shared mobility concepts. These services can be used on-demand and do not require vehicle ownership. As a result, there is a great potential to decrease the use of private cars and to address pollution and traffic problems in metropolitan areas (Pangbourne et al., 2018). However, this urges MaaS providers of a MaaS platform to make consuming mobility as easy as streaming content on the internet.

This will be only possible through connectivity and broad network coverage. In this context, one key technology is the Internet of Things (Melis et al., 2016). With that, intelligent platform services can be enabled by connecting things like cars, traffic lights and other mobility-related things to the internet.

Further, the transport infrastructure can be made intelligent by applying artificial intelligence algorithms to the data. However, this leads also to an increased complexity from a provider perspective which needs to be tackled when creating a platform. It needs to be ensured that multi-modal mobility services are offered to the end-user, which are intelligent and interconnected with each other (Kostiainen & Tuominen, 2019).

Additionally, MaaS can use the current transport system more efficiently by consolidating multi-modal mobility options into a platform (Li et al., 2019). In this context, it will be possible to run optimisation algorithms to optimise city scheduling and routing (Araghia et al., 2020). Statistics from Statista (2017) suggest that the market size of MaaS offerings is expected to grow from 25 billion U.S. dollars in 2017 to 451 billion in 2030.

The Emergence of the MaaS Business Ecosystem

Since the idea of MaaS has been shared with the business community in Hietanen (2014) paper, many MaaS providers who form a business ecosystem with other firms and actors have emerged. The concept of a business ecosystem is that a local firm creates and captures value through the influence of a more comprehensive network of firms (Kamargianni & Matyas, 2017). In this context, the conceptualisation of MaaS is essential to support the development and analysis of such systems. Today, the MaaS business ecosystem is forming and is being conceptualised.

On the one hand, Kamargianni and Matyas (2017) started academic work to identify different actors of the MaaS ecosystem, beginning with the “ego-view” of the MaaS provider. The MaaS provider in such ego networks is considered the focal node, while the actors of the business ecosystem connected to the ego node are called alters. Kamargianni and Matyas (2017) use the concept of an onion shape to compose several layers around the MaaS provider. They identify actors related to the core business, the extended enterprise, and the business ecosystem. However, their examination only grazes the surface of the MaaS business ecosystem.

On the other hand, researchers like Jittrapirom et al. (2017) recognise that several MaaS schemes have been implemented worldwide and have put the initial effort into conceptualising MaaS and its business ecosystem by reviewing its definitions, assessments and key challenges. Here, Jittrapirom et al. (2017) revealed that specific patterns could be observed among the MaaS schemes, including offering services and their basic functionality.

Since the initial work of Kamargianni and Matyas (2017) and Jittrapirom et al. (2017), the MaaS business ecosystem has changed. New actors joined, and different MaaS concepts did form. As the MaaS ecosystem evolves, conceptualisation is vital to include new actors in the business ecosystem.

Although the MaaS business ecosystem is arising, there is still a long way to provide MaaS offerings. The conceptualisation of MaaS is a complex task that requires the combination of multidisciplinary competence areas, including traffic planning, computer science, social sciences, transport systems and organisational psychology (Giesecke et al., 2016). This poses challenges for researchers and practitioners. Nevertheless, researching MaaS from a conceptual point of view could assist MaaS providers in developing business models, regulation policies and financing structures.

1.2 Research Problem

After the background of this research has been introduced, this section maps out the research problem by introducing key academic debates from the literature. Then, those debates are put into context by describing the underlying problem and its relevance. From these points, a thesis statement is formulated.

By offering MaaS with different actors, disruption in the transportation area will happen. Thus, mobility services and MaaS will be increasingly important in academia and practice. Research is needed to conceptualise the MaaS model and its core actors in the business ecosystem. Through designing an artefact or framework that maps out the current state of the MaaS business ecosystem and describes potential relationships of the identified actors, MaaS providers and academics would profit.

Three pain points underpinned by academic papers have been identified to prove the relevance of this research problem in the MaaS literature:

The Academic Debate on Conceptualising the MaaS Business Ecosystem

In literature, an academic debate on what characterises MaaS and how it will impact the existing mobility ecosystem exists (Giesecke et al., 2016; Jittrapirom et al., 2017). The research of Kamargianni and Matyas (2017) shows that the diffusion of innovations in the transportation industry is slow and requires leadership, trust, and strong social interactions between professional groups and suitable organisational contexts. Change to enable MaaS requires a business ecosystem where multiple organisations collaborate, mixing the traditional boundaries of business sectors and companies and involving users in co-creation (Kamargianni & Matyas, 2017). Designing and conceptualising this MaaS business ecosystem by identifying key actors and their respective roles becomes vital. This urge was already acknowledged by Kamargianni and Matyas (2017), who approached the MaaS concept holistically. However, their conceptual work can be only seen as the first steps towards conceptualisation.

In contrast to that work, Giesecke et al. (2016) approach the conceptualisation of MaaS by mapping how existing mobility services fit into MaaS. They develop a four-stage model of how MaaS can be conceptualised. More recent papers like Wong et al. (2020) recognise that there remains a divergence in what exactly constitutes MaaS. For Wong et al. (2020), the concept of MaaS is a vision that works towards societal advantage rather than just a new technology or product. In contrast to this paper, Smith and Hensher (2020) suggest a conceptualisation framework that analyses MaaS policy programs and illustrates how they can be applied.

Another problem is the fuzzy nature of the term and different understandings of definitions, which causes confusion both in academia and practitioner research about conceptualising MaaS. At the same time, the first MaaS providers appear on the market, and the business ecosystem is developing. Jittrapirom et al. (2017) first recognised that although several MaaS schemes have been implemented worldwide, a framework is missing that classifies the unique characteristics and relationships of the actors in a systematic matter. Other authors recognise that the confusion is mainly caused by different perspectives of MaaS and the absence of applying theory to conceptualise MaaS. As a result of these issues, two areas need further research: first, the concept of MaaS and second, the MaaS business ecosystem, in the meaning of the MaaS operators and stakeholders today and in the future.

A Missing Theoretical Foundation for the MaaS Business Ecosystem

The academic debate regarding the conceptualisation of MaaS and its business ecosystem is underpinned by a missing theoretical foundation that could help to conceptualise the MaaS business ecosystem. Giesecke et al. (2016) recognise that their four-stage model can only be considered a high-level model, lacking a theoretical construct that can provide a deeper scientific meaning. Smith and Hensher (2020) add that the conceptualisation of MaaS would benefit from theoretical considerations too.

Currently, many theories have been suggested, but no academic paper applied theory or reviewed the MaaS concept and its ecosystem through a theoretical lens. In recent papers, activity or transition theories have been suggested (Lyons et al., 2020). For example, transition theory can support understanding the development of MaaS through the lens of a fundamental transition, which changes the relationships, routines, assumptions or roles.

Another paper by Karlsson et al. (2020) suggested drawing on institutional theory, which could help to enable the analysis of institutional aspects of transport policy or help to understand and explain organisation as well as individual actions in the business ecosystem. However, these theories provide a very narrow point of view and fail to help conceptualise the actors and their relationships holistically.

Compared to these approaches, Bokolo et al. (2020) introduce the idea of Socio-Technical Systems (STS) theory in combination with Actor Network Theory (ANT). Their paper used this combination to map a multi-tier architecture of e-mobility services based on how human and technical actors share information or coordinate their actions.

ANT enables a description of human or non-human actors, establishing a network to research the relationships between the different actors. Thus, applying ANT to the business ecosystem of MaaS is a promising approach for conceptualisation.

The Need to Map the MaaS Business Ecosystem for Providers & Researchers

The initial MaaS studies focus on the planning aspects of implementing the concept (Jittrapirom et al., 2020; Polydoropoulou, Pagoni, & Tsirimpa, 2020; Wong et al., 2020). However, MaaS has become integral to the large, existing IT companies and service providers' ecosystems (Kamargianni & Matyas, 2017). This adoption highlights the need to conduct new studies to analyse and map out the MaaS ecosystem. While the business ecosystem of MaaS is forming, the MaaS platform builders and researchers seek advice backed up by academic findings.

In addition, policymaker profit by obtaining detailed knowledge about the ecosystem and the key actors. Through that, policymakers can set out new regulations or policies for platform providers based on scientific findings (Giesecke et al., 2016).

Further, mapping the MaaS business ecosystem would enable scholars and practitioners to identify matches and mismatches amongst their understandings (Smith & Hensher, 2020). This would facilitate and govern the development and diffusion of MaaS (Wong et al., 2020). The first attempt to formulate the business ecosystem has already been made by Kamargianni and Matyas (2017).

However, this conceptualisation of the business ecosystem lacks the underlying theoretical approach and is already outdated. A holistic approach to conceptualising the business ecosystem underpinned by theory would help highlight where research is needed and contribute to the materialisation of the concept (Smith & Hensher, 2020). Such an approach would create a foundation as the business environment constantly changes, requiring a continuous analysis.

Problem Statement: *Currently, in the MaaS research domain, there is an academic debate on conceptualising the existing MaaS business ecosystem (Giesecke et al., 2016; Jittrapirom et al., 2017). That is caused by a lack of a structured approach to conceptualise the emerging MaaS ecosystem, causing confusion for researchers and practitioners. This debate is mainly caused by a missing theoretical foundation to conceptualise the MaaS business ecosystem (Smith & Hensher, 2020). Further, pilots and case studies of MaaS reveal barriers in the ecosystem of the actors (Arias-Molinares & García-Palomares, 2020; Ghazy et al., 2021). These barriers prevent the development and diffusion of MaaS (Butler et al., 2021; Smith et al., 2019). Uncovering barriers would facilitate and govern the development and diffusion of MaaS (Kamargianni & Matyas, 2017; Wong et al., 2020). More practitioner research underpinned by a theoretical framework is needed to materialise the concept and understand the actors and their relationships in the MaaS business ecosystem.*

1.3 Thesis Statement

Derived from the problem statement, mapping out the MaaS ecosystem using ANT would be beneficial for the described stakeholders and would contribute to the existing body of knowledge, both theoretically and for practice. Understanding MaaS as a socio-technical network in which relationships are translated would allow new insights to emerge (Alexander & Silvis, 2014). This results in the following thesis statement:

Thesis Statement: *It is possible to develop a MaaS actor network artefact that analyses and examines barriers of the actors in the MaaS business ecosystem.*

The term artefact refers to a conceptual representation of the actor network, capturing the relationships of the MaaS provider with other human and non-human actors within the MaaS network. Thus, the aim is to gain insights into various actors' barriers, contributing theoretically and practically to the understanding of MaaS. This artefact would enable researchers and practitioners to examine the actors and their relationships in the MaaS ecosystem in-depth. Through mapping the actors of the MaaS business ecosystem, barriers to current pilot implementations can be revealed, and the artefact can serve as a foundation for future MaaS development and research. The artefact and the resulting insights can be used for case-specific analysis to formulate policies and regulations to unblock and accelerate the development of MaaS. Additionally, academics and practitioners can identify case-specific gaps in pilot implementations and use the findings to facilitate and govern the development.

1.4 Research Aim, Questions, and Objectives

This research aims to create a MaaS ecosystem using actor networks and demonstrate how barriers to MaaS providers are manifested within it. This is achieved by answering the main research questions in Table 1. The research objectives (RO1-RO3) are outlined below the table.

Table 1. Main Research Questions and Expected Outcomes

Main Research Questions	*Expected Outcomes*
RQ 1*: What are the key elements and actors of the MaaS business ecosystem?*	• A conceptual understanding of the MaaS business ecosystem. • A thematic map of identified actors.
RQ 2*: How can the MaaS business ecosystem be assembled and translated (problematised, interested, enrolled, and mobilised) with ANT?*	• An actor network of the MaaS business ecosystem by a novel combination of MaaS with ANT. • An actor network analysis to group actors revealing relationships and barriers logically. • A thematic examination of barriers currently existing for the actors in the actor network.
RQ 3*: How can the MaaS actor network be used to evaluate case-specific barriers in MaaS business ecosystems?*	• Case-specific inspections of the relationships and translations happening inside MaaS business ecosystems. • An evaluated MaaS business ecosystem actor network artefact through case-specific feedback with expert interviews. • Synthesised success factors, and prospects to overcome barriers in MaaS business ecosystems.

Theoretical Research Objective (RO1): *To explore the key elements, actors, and barriers of the MaaS business ecosystem at a conceptual level with ANT. The purpose of RO1 is to identify actors for the MaaS business ecosystem artefact.*

Design-based Research Objective (RO2): *To map actors and barriers of the MaaS provider to derive the MaaS business ecosystem actor network. The purpose of RO2 is to examine the role of human and non-human actors, their relationships, and the barriers they face in the business ecosystem.*

Empirical Research Objective (RO3): *To critically analyse, evaluate, and synthesise the experienced barriers using the MaaS business ecosystem actor network artefact by conducting case study research. The purpose of RO3 is to enable scholars and practitioners to identify case-specific barriers in MaaS implementations with the help of the MaaS business ecosystem actor network artefact and to formulate success factors to overcome these.*

1.5 Thesis Scope

This section outlines the scope boundaries of the thesis to achieve the previously introduced research objectives. A more detailed scoping of the proposed study is presented as part of the data collection (*see* Section *4.4*). This thesis analyses barriers within MaaS business ecosystems, focusing on these key aspects:

Provider Perspective on the MaaS Business Ecosystem

The scope of this thesis includes analysing the barriers in the MaaS business ecosystem from the provider perspective. This research seeks to understand how European MaaS providers navigate barriers and interact with various actors within their business ecosystem. This perspective is vital, as the provider presents the core of the business ecosystem and is in a relationship with all other actors. Thus, the provider experiences the barriers holistically.

Barriers and Translation in the MaaS Business Ecosystem

This thesis's central focus is identifying, analysing, and systematically discussing the barriers with a specific theoretical lens. Here, the focus is on providing a profound understanding of the barriers in the MaaS business ecosystem by adopting an ANT systems approach. This approach manifests through translating involved actors into actor networks, which enables a holistic understanding.

Scope Limitations

It is important to note that this research will not address the IT development, computing, or knowledge management aspects of MaaS platforms. Furthermore, it will not take a process-oriented but rather an actor network perspective to understand the MaaS business ecosystem. Finally, pure commercial MaaS platforms are not researched, as the digitalisation of mobility services must start at the source. These limitations help to keep the focus on achieving the intended research objectives within the set boundaries.

1.6 Thesis Structure

This thesis is structured into seven chapters. Chapters 1, 2, 3 and 4 are concerned with the thesis's research domain and overall approach. Chapters 5, 6 and 7 detail the findings and contributions of this thesis.

Chapter 1 (Introduction) elaborates on the research background, the research problem, and the statement. This chapter sets out the research aim and objectives and introduces the structure of this thesis.

Chapter 2 (Concepts and Theory for MaaS) constitutes the awareness phase of Design Science Research (DSR). Thus, the concept of MaaS is introduced and reviewed in academic publications and its practical context. Then, an overview of different conceptualisations of MaaS is provided. Further, ANT is introduced, clarifying how it can support the conceptualisation of the MaaS business ecosystem.

Chapter 3 (Systematic Literature Review on MaaS Actors and Barriers) identifies the main actors and barriers in the MaaS business ecosystem (suggestion and development phase of DSR). The SLR identifies those actors and barriers following the strategy of Okoli (2015).

The outputs are then used to build and suggest an actor network that shows identified actors, their relationships, and barriers. This actor network is then applied as the conceptual framework to evaluate the barriers.

Chapter 4 (Research Methodology) presents the underlying research philosophy, the theoretical framework, methodology and methods for collecting empirical data. The chapter sets out the ontological position, explains ANT as the theoretical lens, clarifies how it can be used with DSR and case study research as a methodology, and elaborates on how data is collected using expert interviews. Further, this chapter emphasises the quality criteria of the research and ethical considerations.

Chapter 5 (Results: Cross-Case Evidence of Actor Networks and Barriers) complements and evaluates the MaaS business ecosystem actor network artefact and barriers by analysing the findings of the expert interviews. Thus, it constitutes the feedback and evaluation phase of DSR. Within-case and cross-case analyses are performed, and individual actor networks are created. These form the basis for further evaluation of the barrier patterns by using the findings of the SLR. As a result, barrier themes are amended with empirical evidence and new inductive findings are reported. Then, the key patterns are chosen for further discussion.

Chapter 6 (Discussion of Results) discusses the key patterns from the previous chapter. In terms of DSR, it can be seen as an additional evaluation phase. Three emerging key observations are discussed using the key patterns for each barrier theme. In addition, a managerial discussion abstracts the barrier patterns, and discusses success factors for MaaS. Finally, this chapter concludes on the actor-network and pattern findings by establishing the final CABS framework. This CABS framework demonstrates the amendments and contributions made by this thesis.

Chapter 7 (Conclusion and Reflective Commentary) critically concludes to which extent this thesis has achieved the research objectives (DSR conclusion phase). Here, the contributions to the body of knowledge and the managerial implications of this thesis are emphasised. Then, the limitations of this research are addressed, and directions for future research are suggested. Finally, a reflective commentary revisits the research process and journey of the researcher.

2 Concepts and Theory for MaaS

This chapter elaborates on the main areas of concepts and theory in which this thesis is placed. The chapter is divided into three sections. Section 2.1 highlights the evolution of “as-a-Service” concepts and introduces the terminology used throughout this work. The focus here is on the paradigm shift towards service concepts and the development of service ecosystems. After that, the concept of MaaS is derived and connected to existing frameworks. Then, Section 2.2 researches MaaS in its academic publications and practical context and derives a selection of different conceptualisations of MaaS. In this context, the conceptual understanding of this thesis is presented. Finally, Section 2.3 introduces ANT and clarifies how applying this theory can support the conceptualisation of the MaaS business ecosystem.

2.1 As-a-Service Concepts and MaaS

In the last decade, several models for defining Everything as a Service (XaaS) have been proposed in the literature, mainly concerning products, processes, data & information management, or security (Duan et al., 2015).

This paradigm shift towards defining XaaS is mainly driven by having the ability to shift heavy computational workloads into the cloud. Making services available in the cloud and consumable over the internet for several devices and users opens up new opportunities. Duan et al. (2015) conducted a literature review on concepts and types of as-a-Service (aaS) concepts. Here, Duan et al. (2015) revealed that these services form an extensive network reaching from traditional services, cloud services like internet and web services and service-oriented architecture.

While the cloud can be seen as an enabler for XaaS, Service-Oriented Architecture (SOA) defines how those services work together. Consuming and providing services through the internet makes it possible to consume services almost everywhere in the world. Previously, those services were only available on traditional IT applications hosted on-premises. This trend of providing XaaS enables to consume services through SOA and therefore drives the evolution of services and concepts.

This evolution of services can also drive sustainable innovations. Sustainable innovations or eco-innovations aim to develop innovations that contribute to a sustainable environment through the development of ecological improvements (Xavier et al., 2017). In this context, sustainable innovation has two views: a practitioner (manager) and a researcher. The practitioner wants to understand how sustainable innovations can be developed and used in the organisation, while the researcher is interested in analysing the determinants of sustainable innovation development (Aka, 2019). One central question in this context is how companies or business ecosystems can achieve sustainable innovation through interaction or transformation of markets.

Here, ANT offers a theoretical and methodological tool for answering such questions (Aka, 2019). ANT originated from the science and technology studies scholars Michel Callon, Madeleine Akrich, Bruno Latour, and John Law to examine technological innovations. Their theory makes it possible to explain how things, people and ideas become connected and can be assembled into larger units. Over the years, ANT has become popular in management, organisation, innovation, and sustainability studies.

Recent publications of Seuwou et al. (2016) and Bokolo et al. (2020) use ANT to analyse socio-technical systems. Concretely, Seuwou et al. (2016) use it as a framework to analyse external variables which influence technology acceptance. Bokolo et al. (2020) use ANT in combination with design science methodology in the services domain.

The process of innovation between multiple actors can be formulated by applying such a theory to emerging as-a-Service business ecosystems. In general, service innovation increasingly becomes intangible while services become digitally enabled and co-created around social phenomena (Lusch & Nambisan, 2015). A recent study by Lusch and Nambisan (2015) concerning formulating a service innovation framework describes three elements of a broadened view of service innovation; (1) service ecosystems, (2) service platforms and (3) value co-creation.

Figure 2 highlights the connections between those three themes. In this context Lusch and Nambisan (2015) define a service ecosystem as a self-contained, self-adjusting system of resource-integrating actors connected by shared institutional logic and mutual value creation through service exchange. A service platform with a modular structure consisting of tangible and intangible resources is vital to that ecosystem. This platform facilitates interaction between actors and resource bundles. Underneath the service platform, value co-creation happens as processes and activities from different actors are integrated across the service ecosystem.

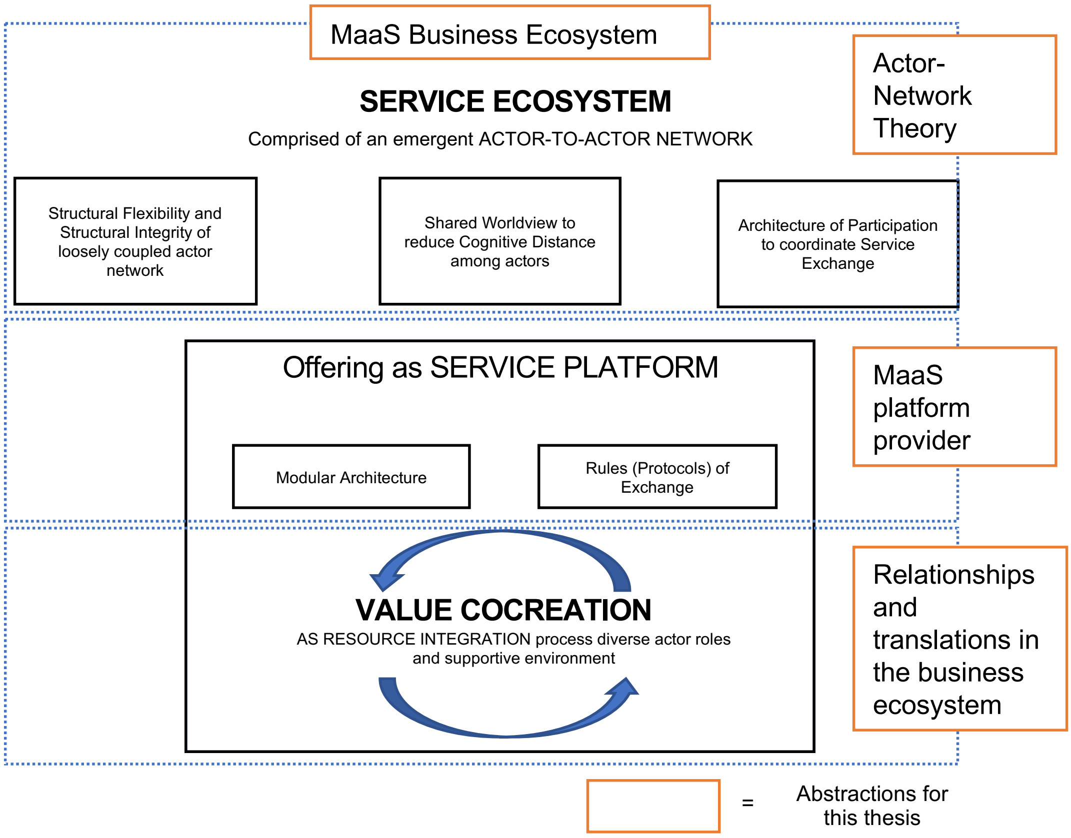


Figure 2. Adapted View for MaaS of Lusch and Nambisan (2015) Service Innovation Framework

This new broadened view of a XaaS and service innovation framework can also be adapted to understanding MaaS (Callegati et al., 2016). Kamargianni and Goulding (2018) define the business ecosystem of MaaS as a wider network of firms that influences how a firm, like the MaaS provider, creates and captures value. This business ecosystem consists of actors including transport operators, data providers, technology and platform providers, ICT infrastructure, insurance companies, regulatory organisations, universities, and research institutions. At its core is the MaaS provider, which merges transport options from different mobility providers into one platform and makes it accessible for end-users as a service. In this ecosystem, companies design their business models by making conscious decisions regarding their position in the value chain and in which function they serve in the delivery chain of MaaS services (Kamargianni & Matyas, 2017).

Comparing the MaaS business ecosystem description of Kamargianni and Matyas (2017) with the view of Lusch and Nambisan (2015) of service innovation, it becomes clear that MaaS can be formulated as a construct using ANT. The service ecosystem of MaaS consists of an actor (provider) network, which exchanges services and data to provide mobility services to end-users (Bokolo et al., 2020). Thereby, the MaaS provider operates the service platform, and through integration with the extended enterprise and business ecosystem, value co-creation is realised (Wong et al., 2020).

2.2 The Mobility as a Service Concept

After establishing an understanding of "as-a-Service" concepts and service innovation, this section performs an initial literature review to introduce key terminology of MaaS and dives into conceptualisation debates of the research. First, the initial search strategy is presented. Then, different definitions of MaaS are reviewed in the literature and conceptualisations of MaaS are presented. From that debate, a conceptual understanding of MaaS for this thesis is derived. Key terminology and explanations for MaaS providers, schemes, mobility services, the ecosystem and its maturity are presented.

2.2.1 Initial Search Strategy

In the academic literature, it is widely accepted that Hietanen (2014) is the first and most central paper introducing MaaS. According to Google Scholar, this paper is the second most cited paper in the academic field of MaaS and has been cited over 300 times. Since this initial research paper, over 440 peer-reviewed papers and many more articles have been published, with increasing numbers year over year.

As presented in the research problem section of this thesis, the controversy around the definition and conceptualisation of MaaS has existed since 2014. This controversy is driven by ambiguity surrounding the concept and is characterised by different views and impacts on the existing mobility ecosystem (Giesecke et al., 2016; Jittrapirom et al., 2017). Specifically, the definitions of MaaS conflict with one another or deal with different aspects of the concept (Jittrapirom et al., 2017).

For this reason, the most cited paper in the literature with over 550 citations is Jittrapirom et al. (2017), dealing with a review of definitions, assessment of schemes and key challenges.

As a result, this thesis uses the two most cited papers of Hietanen (2014) and Jittrapirom et al. (2017) as the starting point for the initial search strategy. This initial search strategy employs a forward and backward search. A forward search in this context means that articles that cite back to these papers are used and analysed in how they contribute to the concept of MaaS. In contrast, the backward search identifies and researches all cited references in a single paper. Both process steps are repeated until no more new insights arise from the literature, and thus a certain saturation is observable. This initial search strategy ensures that key debates and terminology of MaaS are introduced, which results in a clear theoretical foundation. This foundation is then used to systematically identify key actors and their relationships in the MaaS business ecosystem.

2.2.2 A Review of MaaS Definitions

With new technologies arising, the world is moving towards XaaS thinking. In the transportation industry, MaaS is widely regarded as the next paradigm change in transportation. In the literature, multiple definitions and perspectives exist on what constitutes MaaS.

An initial definition of Hietanen (2014) describes MaaS as a concept that combines different transport modes into a bundled package that includes all complementary services like trip planning, reservation, and payments. As a result, MaaS can be viewed as a vision to create a mobility ecosystem that is cooperative, interconnected and provides mobility services without boundaries.

In its academic context, MaaS is located in the Intelligent Transportation Systems (ITS) domain. Those transportation systems are called intelligent, as information technology is used for intelligent trip planning or offering tailored services. IEEE defines ITS as systems that use technologies to develop and improve transportation systems. Hence, MaaS makes use of ITS by aiming to transport persons (or goods) over a predefined distance, combining and integrating different means in a more sustainable way than the current mobility options. Pangbourne et al. (2020) view MaaS as door-to-door multi-mode mobility services backed by digital platforms connecting users and service operators. Compared to that, the MaaS Alliance 2021 defines MaaS as integrating various transport services into a single mobility service accessible on demand. The notion of “on-demand” adds another aspect for MaaS: being available through booking a tariff. Holmberg et al. (2016) focus on this subscription aspect, highlighting the different options from ‘pay-as-you-go’, pre-post pay or a monthly subscription. This subscription must be personalised to the users’ preferences (Atasoy et al., 2015).

Only if being convenient, MaaS will be accepted by its users. However, not only being convenient drives the adoption, but there is also a need to change the existing habits and behaviours of the users. This is required as the success of MaaS is dependent on a behaviour shift away from owning private cars towards using a combination of multiple potentially shared services. Lyons et al. (2020) highlight this behaviour change and further describe an individual choice-making process from the user's perspective for adoption.

Other authors define MaaS from the perspective of the potential benefits it can create. One important aspect is that it can help make transportation more sustainable by offering individual mobility services tailored to the user. Cruz and Sarmento (2020) mention three ways MaaS contributes to more sustainability. First, through offering smart tariffs, which penalise mobility services that are not sustainable. Second, MaaS will contribute to utilising existing assets and transportation systems efficiently. Third, the carbon footprint of ticketing systems is decreased through digitalisation. These perspectives are shared by König et al. (2016), who define MaaS as consuming need-based and individual mobility solutions in a more sustainable way. Besides user-centric definitions, MaaS relies from a technical perspective on multiple technologies. Jittrapirom et al. (2017) highlight ICTs as a central component of MaaS, integrating the users, providers, and services into a platform. An example of such an enabler technology is provided by Melis et al. (2016), highlighting the Internet of Things (IoT). IoT integrates physical things with the virtual world. Concretely, MaaS needs to focus on integrating transport data, data infrastructure, and physical transport infrastructure. Other technical papers by Bokolo et al. (2020), Ebrahimi et al. (2018) and García et al. (2019) define MaaS through system architectures which do incorporate IoT.

In summary, the main goal of MaaS is to provide integrated mobility options for users. This is possible through technology platforms integrating different operators and bundling mobility services and transportation modes. Those platforms need to make use of existing transportation infrastructure (ITS) and provide mobility services in a digitised and efficient way through a simple-to-use platform. The vision is that this infrastructure is made intelligent, for example, by using IoT sensors to provide services with real-time information smartly. This requires strong cooperation between public and private transport providers, but promises more sustainability by better allocating resources and services to the end-users (Hietanen, 2014).

2.2.3 Conceptual Characteristics of MaaS Platforms

Jittrapirom et al. (2017) highlight that there is still a high degree of ambiguity surrounding MaaS, with multiple sources offering definitions of MaaS, many of which may conflict with one another or deal with different aspects of the concept altogether.

Therefore, this subsection picks up the prior discussion and screens the literature for conceptualisations of MaaS. Those conceptualisations include core characteristics. Here, it is important to understand which characteristics exist and how these key characteristics thematically compare in the academic literature. These insights will be used to establish a conceptual understanding of the MaaS business ecosystem for this thesis. In order to gain these insights, conceptual reviews within the literature will be screened. Here, the paper of Giesecke et al. (2016) is used for the initial characteristics and Jittrapirom et al. (2017) for the extended ones. Both of these papers will be amended with more recent findings.

The first need to conceptualise MaaS has been expressed by Giesecke et al. (2016) in their paper “Conceptualising Mobility as a Service”. Giesecke et al. (2016) emphasise a lack of understanding of MaaS on a conceptual level in the research community. In their early research, Giesecke et al. (2016) view MaaS as a socio-technical phenomenon and establish four key characteristics of MaaS, divided into several sub-characteristics.

Their first conceptual characteristic is the nature of travel. In the simplest terms, mobility is about transporting people from A to B. So, it is evident that the nature of travel is a core characteristic when consuming mobility services. Giesecke et al. (2016) focus here on the type of payload that gets transported, the travel goal, the trip purpose, the trip distance, the accessibility and directness, the travel mode and means, the borders and boundaries, and the individual trip phases, when planning the journey. All these are essential characteristics when end-users decide which mobility option to take. This means that a MaaS scheme, which offers such services, needs to focus on all those characteristics. Besides the nature of travel, Giesecke et al. (2016) describe that interoperability is an essential characteristic of MaaS. Interoperability becomes vital as a whole business ecosystem with different mobility providers needs to be integrated. This raises multiple questions regarding interface standards. This characteristic can be considered technical, as it describes how data can be accessed and standardised. While the technical dimension of MaaS platforms is critical, Giesecke et al. (2016) describe the end-user perspective as an additional characteristic. MaaS platforms will only work when accepted by their users and are inclusive for most of the population. As a result, MaaS needs to consider the end-user perspective and include different user group segments and acceptance criteria based on individual user attitudes and behaviours.

However, MaaS will require a behavioural change in society. This cultural and behavioural change will be driven by the need to make mobility services more sustainable.

The final characteristic of Giesecke et al. (2016) is sustainability. MaaS needs to be sustainable in all dimensions to be successful. Through MaaS, the environmental impact should be minimised while being economically viable (environmental sustainability), socially acceptable and inclusive (social sustainability) and economic attractive (economic sustainability).

In summary, the core characteristics of MaaS identified by Giesecke et al. (2016) include (1) the nature of travel, (2) interoperability, (3) the end-user perspective and (4) sustainability in three dimensions. While this is an initial publication on how to conceptualise MaaS, Giesecke et al. (2016) highlight that no conceptual framework exists. In the academic community, their research paper raised awareness and a debate around conceptualising MaaS. However, their paper primarily focused on the end-user perspective and did not detail the core characteristics which enable building a platform.

Thus, this debate has been picked up by Jittrapirom et al. (2017), who set out a set of nine core characteristics to describe existing MaaS schemes and their applications on a conceptual level. These characteristics will be described and serve as a foundation. Then, new studies will be used to enrich this initial list with new patterns or themes found in these studies. In that context, the found themes can be traced back to the literature's theoretical debates.

The first characteristic of Jittrapirom et al. (2017) is the integration of transport modes. MaaS schemes aim to bring together multi-modal transportation consumed through a single interface, allowing users to choose between intermodal mobility services. In this context, Jittrapirom et al. (2017) distinguish the following mobility services: public transport, taxi, car-sharing, ride-sharing, bike-sharing, car-rental and on-demand bus. In a broader context, when leaving the city, also long-distance buses and trains, flights, and ferries are included. This characteristic is certainly shared with the research community. For example, Giesecke et al. (2016) describe it as interoperability. Christiaanse (2019) emphasise the technical side and presents a value-net model to describe the integration. Utriainen and Pöllänen (2018) highlight that different integration levels of transport modes exist. Here, Cooper et al. (2019) suggest a tri-opt integration between vehicles, smart cities and MaaS within the private sector.

The second characteristic commonly shared in the literature is the tariff option. Jittrapirom et al. (2017) describe this characteristic as having options to choose between different mobility packages. The MaaS platform offers these packages and can bundle various transport modes and price them with different strategies. For example, a customer can be charged by the number of km/minutes/points that have been utilised or through a flat that is paid monthly. This strategy is called pay-as-you-go. Cooper et al. (2019) suggest other dynamic pricing strategies based on complex methods to model demands. Zöschinger (2019) emphasises that tariffs and subscription pricing must be economically competitive to attract customers. It becomes clear that pricing and tariff are essential characteristics and require to be transparent while they need to be adapted to the customers with dynamic pricing models.

The third characteristic in the literature is the one-platform idea of MaaS. Jittrapirom et al. (2017) emphasise that this platform needs to be digital, meaning that it is consumed through a mobile app or a web page and makes use of all other characteristics by giving end-users access to all the necessary services like trip planning, booking, ticketing, payment, and real-time information. The platform can even include third-party integration to valuable services. This view is also shared by Cooper et al. (2019): to focus on the integration perspective, opening up for third-party integration. This vision of having one central MaaS platform is excellent but lacks reality. Therefore, Christiaanse (2019) contradicts the one-platform idea, stating that a monolithic view is too limited and neglects the distributed nature of MaaS. Many MaaS platforms will be forming, but the key will be the usage of standards. Kamargianni and Matyas (2017) recognise this and suggest using an open Application Programming Interface (API) standard for the platforms. A first blueprint of an API between transport operators and MaaS providers has been developed by Felici et al. (2019). As a result, a MaaS platform needs to be open, easily accessible and use standardised technology.

The fourth characteristic and most important one in the context of this thesis is that the platform exists of multiple actors. Jittrapirom et al. (2017) recognise that MaaS is built on interactions between different groups of actors through a digital platform. They identify, for example, demanders of mobility (for example private or business customers), a supplier of transport services (for example private or public) and platform owners (for example third-party providers, public transport providers or authorities). In this context, Kamargianni and Matyas (2017) first introduced the business ecosystem perspective and identified seven actors distributed over several layers.

However, this ecosystem lacks underlying theory and relationships, and new actors joined since then. It is evident that a MaaS platform can only work if the business rules are clear. These business rules require that all participants act under predefined and similar conditions. Otherwise it will end in chaos as described by Zöschinger (2019). It might even require more than rules in the beginning. When multiple parties join to form a platform together, trust is essential. Therefore, governance models need to be implemented to prevent fraud. Here, Nguyen et al. (2019) describe how blockchain can be used as a technology to achieve trust.

In addition, Karinsalo and Halunen (2018) suggest smart contracts towards a fair combined mobility service. The use of smart contracts enforces rules that the different actors define. Potential security threats of multiple actors have been reviewed from an insider perspective by Callegati et al. (2018).

This was already an example of the fifth characteristic: the usage of technologies. Jittrapirom et al. (2017) identify that a MaaS platform needs to combine different technologies to enable MaaS. As Bokolo et al. (2020) suggested, data processing and fusion will become increasingly important, requiring big data architectures. Additionally, as the amount of data continuously increases, the data processing technology needs to be scalable and secure. However, it is only scalable when the data formats are standardised. This depends on smart devices, infrastructure, mobile computers, and smartphones. However, reliable internet connectivity is required. Core technologies are Wi-Fi, mobile standards like 4G or 5G, Global Positioning System (GPS) and smart infrastructure with IoT devices. This demands trust and cooperation between the different parties. As previously mentioned, blockchain can be the technology to track transactions and ensure this trust (Karinsalo & Halunen, 2018). Using those technologies also raises concerns about data security.

This point was detected and emphasised early by the papers of Kamargianni and Matyas (2017) and Callegati et al. (2016). However, Utriainen and Pöllänen (2018) highlight that the use of such technologies is not only crucial for developing such a platform. Technology will be a critical factor in the users' acceptance and adoption (Caiati et al., 2020).

The sixth characteristic is demand orientation. Jittrapirom et al. (2017) describe demand orientation as the user-centric paradigm, as it seeks to offer the best transport solution from the customer’s perspective. Thus, the demand arises by attractively offering mobility services. Utriainen and Pöllänen (2018) emphasise that mobility services must be offered flexibly to be attractive. Demand is directly correlated with the acceptance of mobility services. Here, the first studies of Schikofsky et al. (2020) and Mola et al. (2020) explore the motivational mechanism behind the demand and intention to adopt mobility services. Other studies by Jittrapirom et al. (2020) and Loubser et al. (2021) explore the demand for MaaS by observing the first pilot implementations of MaaS.

The seventh characteristic is the option for new users to register to the platform. Jittrapirom et al. (2017) have a rather simple understanding of this. From their perspective, an account is required for a single individual or, in some instances, an entire household. This account consumes mobility services through different tariff options like subscriptions. While considering just one account to register is easy, implementations of accounts and functionality for a MaaS platform may differ in different cities, countries, or regions due to local laws and policies (Smith & Hensher, 2020). One important aspect to mention is privacy considerations. By registering to a MaaS platform, a user account will be generated.

As the user is consuming mobility services, personal travel information can be collected, and potentially, movement profiles of the user can be created. This information falls under the General Data Protection Regulation (GDPR) of the European Union. As a result, Cottrill (2020) research shows how GDPR requirements can be addressed in MaaS platforms by using privacy by design, consent, and protection. Even more, Murati (2020) recognises that no legal base exists for passenger rights.

In summary, it becomes clear that the simple registration characteristic of Jittrapirom et al. (2017) is much more complex. Thinking of the MaaS ecosystem, not only the enrolment or registration of end-users is essential. There will also be an enrolment for business users or third-party users, which are part of the MaaS business ecosystem.

The eighth characteristic is the personalisation of the platform. By consuming mobility services over the platform, the services can be personalised. Jittrapirom et al. (2017) explain that characteristic personalisation ensures that the end-user’s expectations and requirements are met if each customer's uniqueness is considered. The platform can provide the user with specific recommendations and tailor-made offers based on personal preferences or data collected. The preferences can be derived and linked by leveraging social logins based on their social network profiles. Cooper et al. (2019) claim that personalisation can be achieved by opening the platform to third parties and allowing personalised advertisements and services. Barreto et al. (2018) add that using Artificial Intelligence (AI) algorithms will be present in any MaaS platform. AI algorithms support personalisation by, for example, helping the decision process of the different mobility options, calculating a price, or offering personal incentives. This characteristic is dependent on the business ecosystem itself.

To offer personalisation, the actors of the MaaS business ecosystem need to exchange data with one another. Therefore, it needs to be open and secure.

The ninth characteristic of MaaS platforms is customisation. Customising in this context enables users to modify the offered service options to their preferences. In contrast to the last characteristic, personalisation, customisation is more of an individual process or capability. According to Jittrapirom et al. (2017), users can compose and build whatever mobility package fits their preferred travel experiences best. He and Csiszár (2021) agree with the definition of customisation being the choice, while personalisation is a recommendation, and they suggest an analysis method for customisation settings and evaluate 20 MaaS platforms. They distinguish between the base and additional functionalities, which users can customise in the MaaS platform. The main goal of customisation is to increase the attractiveness of MaaS among travellers to achieve customer satisfaction and loyalty.

While reviewing and critically analysing the nine core characteristics of MaaS based on Jittrapirom et al. (2017) research, the complementation with the latest papers revealed the complexity of each characteristic and the domains where current research is placed. These characteristics will play a vital role in conceptually defining the MaaS understanding of this thesis and support the understanding of key terminology that will be introduced. Further, it is also possible to amend the existing perspectives with new ones. One example is Sochor et al. (2018), who introduced the idea of integrating societal goals into MaaS in areas like car ownership and usage (congestion and emissions), use of resources (material, energy), existing infrastructure, mobility options, and urban planning. This would lead people towards a mindset change, but it also requires thoughts before implementing a MaaS platform, as it would need to be sustainable by design.

2.2.4 Conceptual MaaS Understanding of this Thesis

After a generic conceptual understanding of MaaS was established and initial limitations and barriers were outlined, it is important to understand which conceptual perspective this thesis adopts. The conceptual understanding of this thesis merges two views and is underpinned by ANT. First, it leverages the service innovation framework of Lusch and Nambisan (2015), introduced in Section 2.1. Second, it uses the conceptualisation of Kamargianni and Matyas (2017), which introduces the business ecosystem of MaaS. Therefore, this idea of conceptualising the ecosystem is taken as the starting point for further research in this thesis.

Figure 3 highlights the conceptual understanding of the MaaS business ecosystem of this thesis. The core characteristics of MaaS serve as a foundation of the conceptual understanding. These can be seen as attributes of the emerging MaaS business ecosystem. Previously the characteristics of Jittrapirom et al. (2017) have been described and enriched with more recent papers (Section 2.2.3). One example of such an attribute for the business ecosystem is the fifth core characteristic: the usage of technologies. Almost all actors in the MaaS business ecosystem must use different forms of hardware and technology to offer or exchange their services with other actors in the network (Polydoropoulou, Pagoni, & Tsirimpa, 2020). Like this example, all other characteristics can also be seen as attributes that will be used as a lens to describe the relationships between the MaaS provider and other actors.

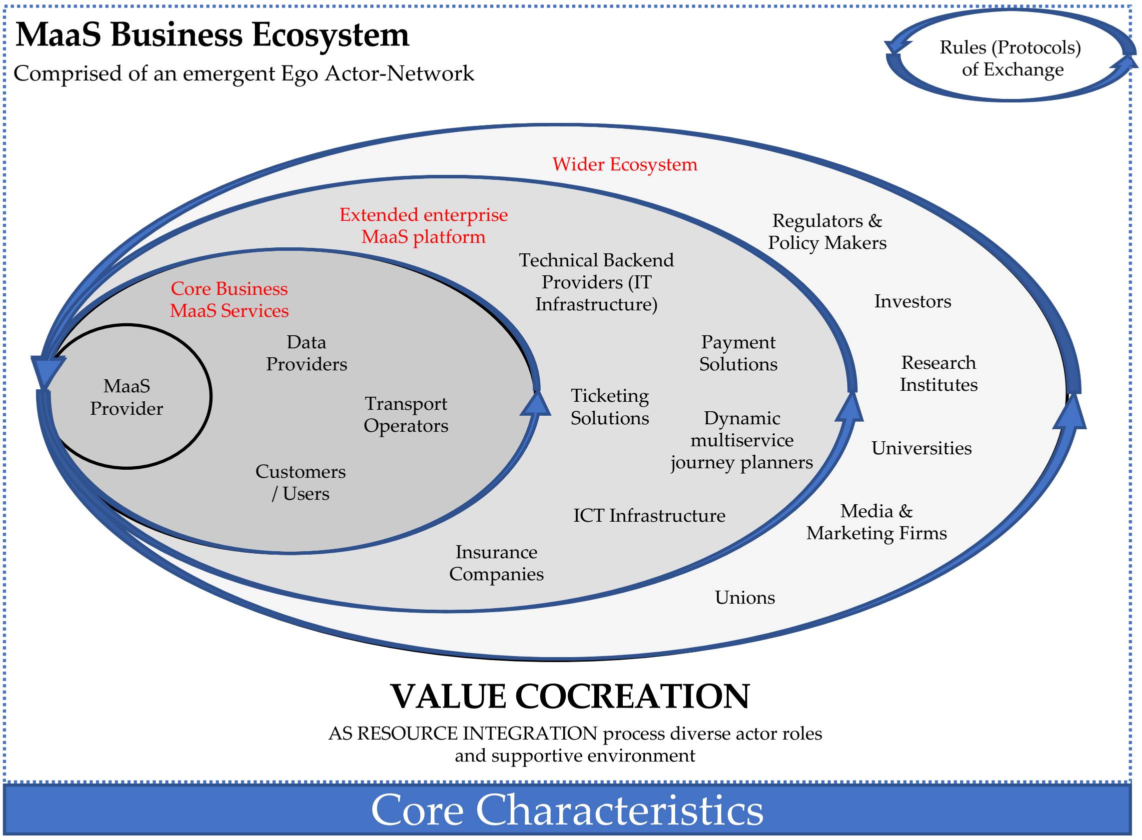


Figure 3. The Conceptual Understanding of the MaaS Ecosystem adapted from Kamargianni and Matyas (2017)

On top of these foundational characteristics sits the emergent business ecosystem, consisting of known and unknown actors forming an actor network. The first work to uncover the actors of the business ecosystem has been done by Kamargianni and Matyas (2017). This business ecosystem has been adapted and leveraged to develop the conceptual framework for this thesis. Initially, this business ecosystem was composed of three layers centred around the MaaS provider.

The first layer is the core business layer. For this thesis, the actors within that layer constitute and enable the MaaS services. This layer is considered the heart of the business ecosystem and includes actors like data providers, transport operators or customers.

In the paper of Kamargianni and Matyas (2017), the second layer, the extended enterprise, includes the complementors and second-layer suppliers, namely, technical backend providers, payment solutions, ticketing solutions, dynamic multi-service journey planners, ICT infrastructure and insurance companies. This thesis understands this layer as a MaaS platform that includes all actors which provide technical or non-technical functionalities and IT infrastructure.

The third layer can be described as the wider ecosystem. This layer adds regulators, unions, universities, media & marketing, and policymakers as actors in the ecosystem. All these actors affect the MaaS platform and are involved in business operations.

The paper of Kamargianni and Matyas (2017) focuses on actors that could enable (or disable) the concept at its first step. Thus, their examination only grazes the surface of the business ecosystem. As the MaaS business ecosystem evolves, new actors must be added.

Those new actors will be identified through an SLR in Chapter 3. For that, this conceptual understanding is used, and the identified core characteristics, in combination with the layers, can be used for clustering.

Another point is that Kamargianni and Matyas (2017) only described the actors and acknowledged that relationships between those actors exist. An essential difference in the conceptual understanding of this thesis is that the actors can exchange and generate value by co-creation and rules of exchange within the MaaS business ecosystem. This is visualised in Figure 3 through the circular arrows over the different layers.

2.3 Actor Network Theory and Conceptualisation

This section introduces ANT and shows how it can help to conceptualise the MaaS business ecosystem. First, subsection 2.3.1 introduces the core idea of ANT: that social and technological factors are equal. Second, subsection 2.3.2 explains basic and advanced concepts of ANT that support the conceptualisation. Third, subsection 2.3.3 elaborates on how ANT can be graphically represented with syntax. Finally, subsection 2.3.4 describes how ANT can be applied to identify and map out the business ecosystem of actors for MaaS using the conceptual understanding from subsection 2.2.4.

2.3.1 ANT and Equality of Social and Technological Actors

ANT was developed in the 1980s by Bruno Latour, Michel Callon and John Law to study phenomena in which both human and non-human actors are in a relationship and form a network. Law (1992) emphasises that networks can be studied by attributing and recognising essence to human actors, which can be technological or natural objects. Thus, being material-semiotic is the key rationale behind ANT (Law, 2008). As a result, social and technical aspects are treated equally important, and the world is considered to be full of hybrid entities (Latour, 1993). Therefore, ANT denies the difference between human and non-human entities at an ontological level (Alexander & Silvis, 2014). It rejects an essentialist position and sees properties as network effects rather than innate characteristics of an entity (Tatnall, 2005). As a result, all entities can influence the development of an actor network (Alexander & Silvis, 2014).

While ANT has been initially developed for sociology, anthropology, and science and technology studies, other academics have gradually adopted it over the years, including Information Systems (Alexander & Silvis, 2014).

ANT is also essential in service innovation to explain how service networks and ecosystems form (Carroll et al., 2012; Lorna & Janet, 2011). In ecosystems, ANT examines the formation of a network considering human and non-human actors and the resulting alliances (Burgess & Tatnall, 2002).

An Assemblage of Actors called Actor Network

ANT is often described as the sociology of translation and has been mostly adopted as a tool to explore collective sociotechnical processes in which human and non-human actors play a significant role in forming complex networks called assemblages (Seuwou et al., 2016). This assemblage is formed out of four main components (1) actors, (2) having links and relationships, (3) forming a network, and (4) performing an action.

Actors can be anything natural, technical, or human, such as a group of people or a piece of software or material. Callon (1984) describes three principles ensuring that human and non-human actors are treated equally: agnosticism, generalised symmetry, and free association. Agnosticism is described as analytical impartiality, which is required towards all the actors involved. Generalised symmetry states that conflicting perspectives of the involved actors using abstract and neutral vocabulary work the same for human and non-human actors (Tatnall, 2005). The last principle of free association requires eliminating and abandoning all a priori distinctions between the technological and the natural (Callon, 1984; Singleton & Michael, 1993).

Links and relationships exist between different actors and are achieved through translation. Here, translation enables the definition of links or relationships which describe how resources or knowledge are exchanged in the actor network.

Through the interactive assembly of actors with links and relationships, heterogeneous networks are formed, which are made of people, organisations, agents, and many other objects (Law, 1991). Actors can join and leave such networks. For this reason, formed networks are unreliable and can become unstable.

Actor networks only become reliable by understanding the actions and interests of the actors in the network. As new actors enrol in such networks, actors' alliances and translations can change. This can result in a change and reformation of the network. Then, black boxes must be opened, and the actor network must be re-evaluated (Callon, 1986).

2.3.2 Core and Advanced Concepts in ANT

This subsection introduces basic and advanced concepts in ANT found in the literature. The initial review is based on the findings of Alexander and Silvis (2014) and is enriched with other findings from the literature. The concepts introduced serve as the syntax for the graphical representation in the following subsection.

Actors

Actors work as independent units which are interacting with one another. Actors can be human, technological or natural elements (Latour, 1984). Each actor shapes the network to its own needs. Thus, the resulting network is constantly transformed and shaped by translating the actors’ needs. In a network, actors can modify, deflect, betray, add to it, or let it drop (Latour, 1993).

Alliances

Alliances emerge once the translation has been successful and the actor is enrolled into the network (Alexander & Silvis, 2014). Actors are forming alliances with other actors. These alliances are readjusted constantly as actors are no intermediaries and keep changing. There is cost and risk associated with alliances. For example, each actor in the network has its conditions and terms for joining or being part of an alliance. Through the principle of irreduction, any actor can be allied with another actor (Harman, 2009). Actors can challenge existing alliances or enter alliances causing conflicts of interest (Ramiller & Wagner, 2009). As a result, compromise and adaption are required.

Translation

Callon et al. (1983) describe that translation involves all strategies through which an actor identifies other actors and puts them in relation to each other. Thus, translation is an essential component of ANT. For this reason, ANT is often called the sociology of translation (Hassard et al., 1999). Pentland and Feldman (2007) argue that translations in networks can never be perfect, and actors need to understand each other mutually. However, translation offers a way to understand how ideas and objects change as they move through different contexts in the network. Further, translation highlights contradictory interpretations or explanations that are conflicting. Lorna and Janet (2011) explain how artefacts can result from such negotiations between actors. Especially in service innovation, translation with ANT can be used as a theoretical lens to study development and adoption.

The translation within the network is achieved through common definitions, meanings and inscriptions attached to the technology (Lorna & Janet, 2011). In the original work of ANT, Callon (1984) describes four moments of translation:

Problematisation, Interessement, Enrolment and Mobilisation

Problematisation is the first moment of translation and relates to the process of formulating the problem or network that needs to be researched. A focal actor establishes itself as an Obligatory Passage Point (OPP). Being an OPP between the other actors and the networks means that the focal actor becomes indispensable to them (Callon, 1986). As a result, problematisation can be seen as a product of alliances or associations between the actors by being an OPP (Callon, 1986). Taking the MaaS business ecosystem as an example, the actor network would be established starting with the focal MaaS provider who offers a platform (OPP) on which other actors can offer their services.

Interessement is considered the second translation moment when the focal actor convinces other actors to accept its position in the network (Callon, 1986). Taking the MaaS business ecosystem as an example, this would reflect the process in which the MaaS provider outlines why joining the actor network could be beneficial for the other actors. Law and Callon (1988) describe this as a recruiting process in which the roles and power relationships in the actor network are negotiated. If this process has been successful, enrolment will take place.

Enrolment is the third moment when the other actors accept the focal actor and their roles within the new network. Successful enrolment forms a network of alliances, and inscription happens. The inscription is the process of creating technical artefacts which enforce the power and position of an actor's interests in the network (Sarker et al., 2006). The properties and attributes of an actor or an alliance result from the complex inscription of human and non-human actors (Lorna & Janet, 2011).

Inscription and translation are iterative, meaning they constantly flow as the network changes. As a result, the enrolment process defines the actors of the network.

Mobilisation of allies is the fourth and last moment of translation. The actors can create sub-networks based on alliances and the newly created network (Burgess & Tatnall, 2002). Mobilisation is the process in which the actors or alliances in the network establish representatives to avoid betrayal in the actor network (Callon, 1984).

Durability

Durability is considered the strength of alliances formed between the actors in the network. An actor is considered a single snapshot amidst continuous change happening in the network (Alexander & Silvis, 2014). Once the alliances get more robust and the innovation or technology gets more mature, the durability of the network increases. Tatnall (2005) describes durability as the process in the network in which actors feel no need to spend time opening and looking inside black boxes and just accepting these as given.

Intermediaries, Mediators, and Black Boxes

Latour (2007) distinguishes between intermediaries and mediators. Intermediaries are described by Latour (2007, p. 39) as a construct that “transports meaning or force without transformation”. In contrast to intermediaries, Latour (2007, p. 39) noted that mediators “transform, translate, distort, and modify the meaning or the elements they are supposed to carry”. Intermediaries and mediators can be represented through black boxes.

Black boxes are well-established networks of allied actors which are so strong that they are only recognised as one actor (Alexander & Silvis, 2014). However, if new actors enrol in the network or alliances change, black boxes must be reopened, and their content must be reconsidered (Callon, 1986).

For this reason, black boxes are sometimes called simplifications as they reduce the complexity of complex associations and sub-networks into a simple black box accepted by the network actors (Tatnall, 2005). Hanseth et al. (2006) describe that the black boxes are mainly used to reduce complexities in the network by merging certain areas into black boxes. Being described as sealed actor networks, they are taken for granted by other actors in the network. However, those simplifications can be challenged anytime, leading to new actor networks.

2.3.3 Graphical Representation Syntax for ANT

Alexander and Silvis (2014) recognise that the utility of ANT can be increased by representing actor networks through graphical syntax. In this context, Alexander and Silvis (2014) found three graphical representations of ANT in the academic literature.

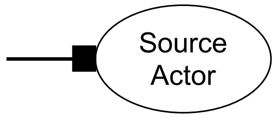
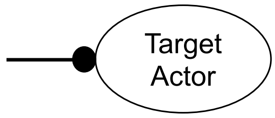
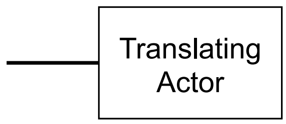
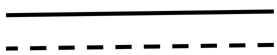
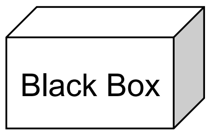
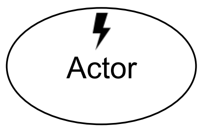
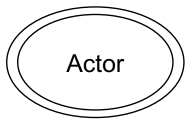
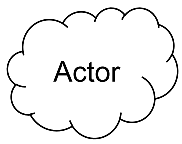
The first modelling approach, Dynamic Actor Network Analysis (DANA), was introduced by Bots et al. (1999), who use text-based syntax with mathematical expressions. The second modelling approach by Potts (2008) introduces an ANT model for system designers to understand the context in which their users approach the systems. The third modelling approach identified has been introduced by Tsohou et al. (2012) and is a set of representations in a dynamic network.

All of these modelling approaches have shortcomings identified and discussed by Alexander and Silvis (2014) in more detail. To overcome these shortcomings, Alexander and Silvis (2014) suggested a novel syntax that enhances the three presented modelling approaches.

Core and Extended Syntax for ANT

The ANT syntax of Alexander and Silvis (2014) expresses the translation graphically by differentiating between different ANT concepts that are either basic, complex, or pragmatic concepts (*see* Table 2).

Table 2. Graphical ANT Syntax as introduced by Alexander and Silvis (2014)

ANT Concept	*Definition*	*Graphical symbol*
Source	Basic ANT concept, any entity that is included in an ANT analysis.	
Target	Basic ANT concept, any entity that is included in an ANT analysis.	
Translator	Basic ANT concept, any entity that is included in an ANT analysis that translates between a Source and Target.	
Relationships	Basic ANT concept that indicates the relationship between a Source, Translator and Target.	
Black Box	Complex ANT concept indicated by multiple actors with strong relationships.	
Action at a distance	Complex ANT concept showing an actor influencing another that is far away.	
Main research actor	Pragmatic ANT extension that place visual emphasis on the main focus.	
Exemplary instances	Pragmatic ANT extension that shows actors who are not part of the network.	

Following Callon et al. (1983), actors can have three roles during the translation process: the source actor, the target actor and the translator. The translator translates the source actor into the target through the four translation moments. If the translation has been successful, the target joins the actor network, and a relationship between the source, translator and target is established.

Besides these ANT core concepts, complex ones like black boxes and action at a distance are expressed through combing constructs of the core syntax (Alexander & Silvis, 2014). A black box reveals multiple actors who are bonded through robust relationships. The action at a distance concept indicates if an actor develops a power influence towards another actor that is physically or conceptually far away (Alexander & Silvis, 2014; Latour, 1987).

In addition to the ANT core and complex concepts, Alexander and Silvis (2014) suggest two pragmatic extensions. The first extension has a main research actor that is the focus of the analysis, constituting the core of the network. The second extension distinguishes actors not to be found in an empirical dataset (Silvis & M. Alexander, 2014). However, they might still be part of an emerging actor network.

2.3.4 Viewing the MaaS Business Ecosystem through ANT

This subsection describes how the MaaS business ecosystem can be seen through the lens of ANT. For that, the moments of translation combined with the graphical syntax are applied to investigate and explain the development of the MaaS business ecosystem.

Before applying the concepts from the previous subsections to the MaaS business ecosystem, one more problem needs to be considered: the factor of time.

Cho et al. (2008) highlight that it is important to consider ANT with events happening at different times. They identify three steps that need to be taken iteratively by the researcher: identifying the encounter that challenged the network, then analysing how the encounter changed the network and then synthesising multiple encounters into a logical collective. The notion of time and change in actor networks has also been expressed by Tsohou et al. (2012). They suggest the usage of freeze frames, which reflect the actor network at a certain point in time. Initially, an event-driven view of reviewing the development of an actor network was introduced by (Newman & Robey, 1992) with the encounter-episode framework. The encounter-episode framework describes a process or network resulting from different encounters and episodes (Newman & Robey, 1992). This view has been adopted by Silvis and M. Alexander (2014), who define “encounters” as events that challenge the existing formation of actors in the network and episodes occurring between encounters.

This thesis will also view the MaaS business ecosystem using the encounter-episode framework and produce three encounters or freeze frames. The first encounter is the starting point of the research, reflecting the actor network at the stage when Kamargianni and Matyas (2017) published the first paper on the business ecosystem of MaaS (actor network v0). This encounter will be described in the next paragraph. The second encounter or freeze frame produced will be through the Systematic Literature Review (SLR) in Chapter 3, which highlights changes in the network and systematically searches for new actors and their barriers (actor network v1). The third encounter consists of multiple actor networks that will be generated by applying it in case companies and interviewing experts through in-depth interviews (actor network v2).

These actor networks are part of the within-case analysis and can be found in Section 5.1. The encounter-episode framework adapted to the three encounters in this thesis has been visualised in Figure 4.

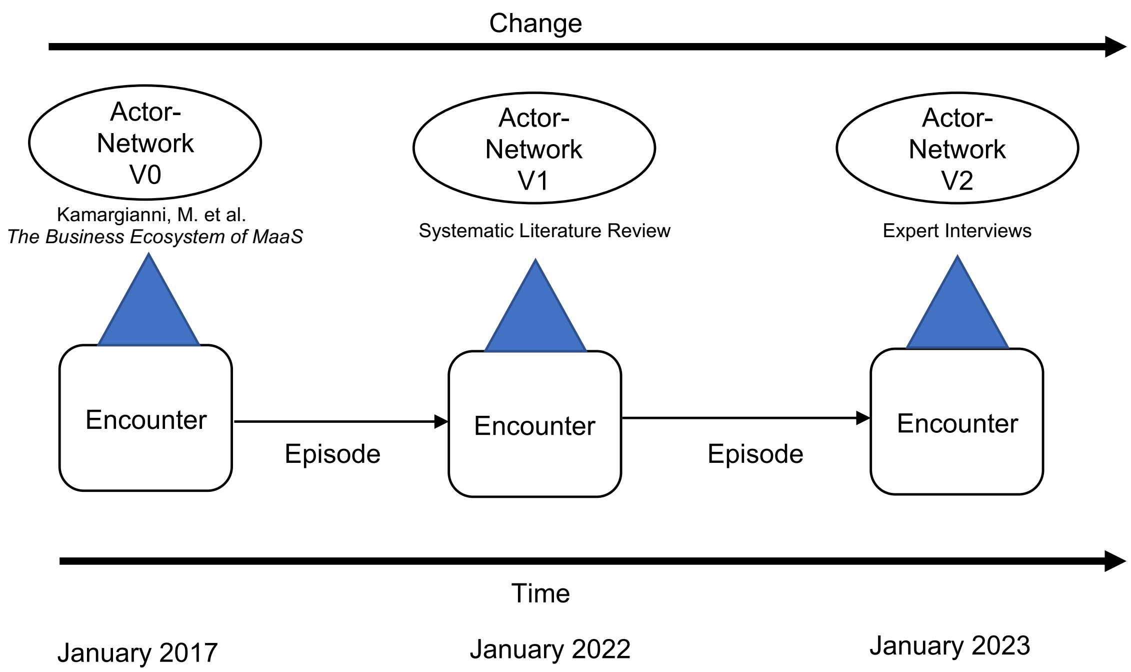


Figure 4. Encounter-Episode Framework with Three Encounters of this Thesis

Silvis and M. Alexander (2014) suggest that each encounter needs to contain specific information, including a unique identifier, the date when the actor network was produced and the name of the person who produced the model. The first encounter with the MaaS business ecosystem will be described in the following.

First Encounter of the MaaS Business Ecosystem

For the first encounter, the MaaS business ecosystem of Kamargianni and Matyas (2017) is taken as a starting point (Section 2.3.4). Further, the relationships between the different actors are assumed but not described in detail. The relationships and additional actors will be identified through the SLR in the next chapter. For this reason, the moments of translation, problematisation, interessement, enrolment and mobilisation are portrayed on a high level for the initial version of the actor network.

The first moment of translation is the problematisation, through which the different actors of the network are identified, and their OPP is specified. In total, Kamargianni and Matyas (2017) identified 16 different actors distributed over three different layers. Two things can be already observed looking at this initial business ecosystem.

First, the main research actor is the MaaS provider. The MaaS provider is considered an actor who provides services to customers through a platform. Therefore, the MaaS provider constitutes the focal node of the actor network. Second, multiple actors exist around the MaaS provider. Kamargianni and Matyas (2017) grouped the actors into seven actors: transport operators, data providers, technology and platform providers, ICT infrastructure, insurance companies, regulatory organisations, universities, and research institutions.

According to the graphical syntax of ANT, most of these actors constitute black boxes, as each consists of multiple actors bound by solid relationships. These black boxes will be re-opened in the SLR, and new actors will be identified, either attached to an existing black box or a new one. Two actors can be viewed as complex actors. Regulatory organisations are considered exemplary instances that influence the actor network but are not directly part of it. Universities and research institutions act at a distance, as they influence how the business ecosystem is developing and thus influence the actors from the network, far away. The translation moment Interessement describes why joining the actor network is beneficial. This is mainly covered by the OPP or translator between the different actors and the focal actor. Only direct relationships with the focal actor are reviewed for the first encounter. The enrolment happens by accepting the relationship to the focal actor and results in the inscription. Thus, inscription happens at each encounter, while the translation process inscribes the actor network.

The actor network's actual change and development happen between the episodes' encounters. Mobilisation is not visible for the first encounter. Figure 5 shows the first encounter with the MaaS business ecosystem. This actor network serves as the basis for the second encounter. For this, the SLR in the following chapter researches more actors, OPPs and their translations.

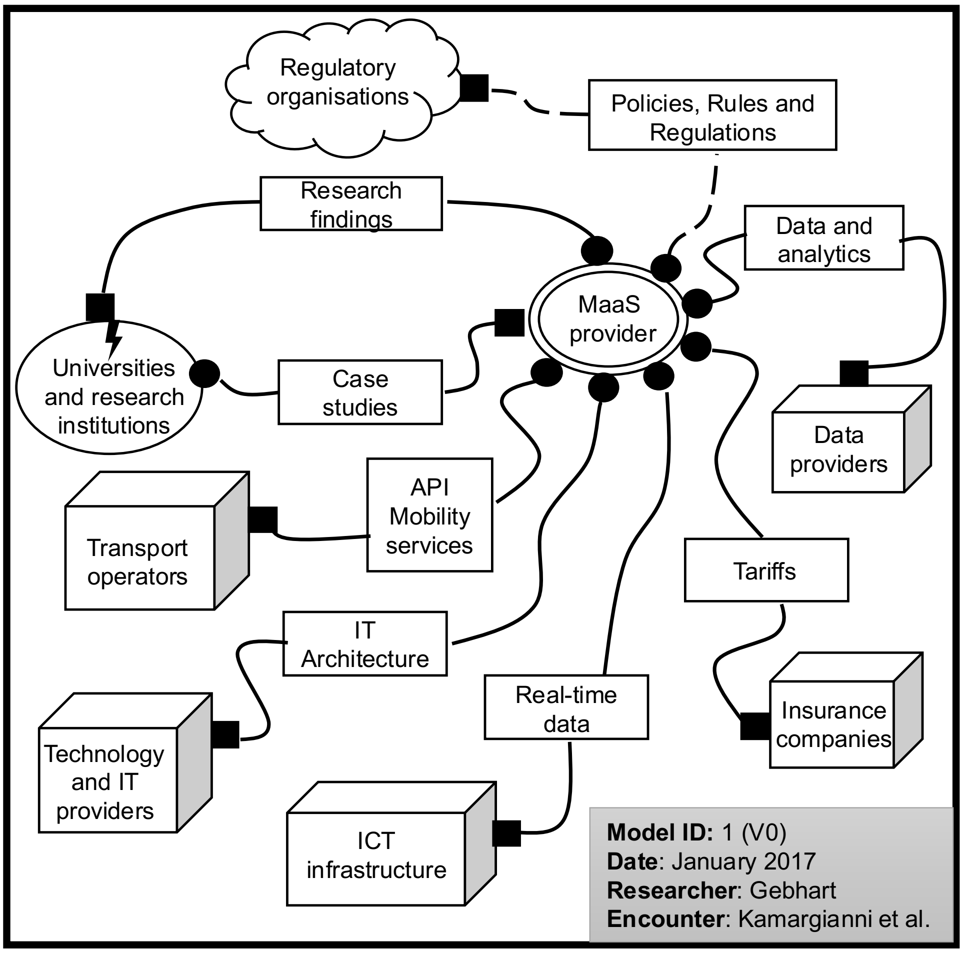


Figure 5. First Encounter of the MaaS Business Ecosystem Actor Network (v0)

3 Systematic Literature Review on MaaS Actors and Barriers

The last chapter revealed the initial challenges for the conceptualisation of MaaS. It introduced ANT, a conceptual theory which can be used to research and produce an actor network of the MaaS business ecosystem. For that, a first encounter with the business ecosystem based on the research of Kamargianni and Matyas (2017) has been constructed. However, as this encounter is from 2017, the actors and their relationships identified are outdated, and the actor network needs revision. Therefore, an extensive SLR would systematically identify new actors and research their barriers to construct an up-to-date actor network artefact for further empiric research. In order to achieve that goal, Section 3.1 introduces the strategy for conducting the SLR. Sections 3.2 to 3.7 follow the steps of this strategy to select, extract and synthesise actors and barriers from the academic literature. Section 3.8 builds, based on these insights, a new encounter for the MaaS business ecosystem actor network. Finally, the resulting actor network with the barrier themes will be used for further evaluation.

3.1 Strategy for conducting the Systematic Literature Review

Fink (2005) defines an SLR as “a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars and practitioners” (p. 6). This definition highlights the systematic and explicit nature of SLR that needs to be followed. Here, an SLR aims to minimise bias through exhaustive literature searches to develop a reliable knowledge base (Tranfield et al., 2003).

SLRs originated from health sciences and helped compile and summarise other papers, making the literature search transparent (Hart, 1998). In the academic literature, many guides exist for conducting an SLR that spread over a broad range of research domains. The first peer-reviewed guide that introduces SLR methodology to information systems research is the one by Okoli (2015). The field of information systems is a diverse methodological field and requires synthesising both quantitative and qualitative studies (Okoli, 2015). For that, Okoli (2015) incorporates Kitchenham et al. (2009) software engineering recommendations, including reviewing primary studies using design science methodologies. Identifying the actors of the MaaS business ecosystem is located within that area and requires synthesising human and non-human actors from qualitative and quantitative studies. Thus, this research adopted the eight-step guide to conducting a SLR in information systems research of Okoli (2015). Step 2, draft protocol and train the team, is skipped in this thesis because only the author of this thesis is producing the SLR. The following eight steps of Okoli (2015, p. 43) to conduct an SLR will be performed in the following sections of this chapter:

1. **Identify the purpose**: need to clearly identify the review's purpose and intended goal in order to be explicit to its readers.
2. **Draft protocol and train the team:** if > 1 reviewer, detailed protocol and training for all reviewers is needed to ensure consistency in how they execute the review.
3. **Apply practical screen:** screening for inclusion requires the reviewers to be explicit about what studies are considered and which are eliminated. For the excluded studies, there must be practical reasons and justifications.
4. **Search for literature:** being explicit about the details of the literature search (search strings).
5. **Extract data:** systematically extract the applicable information from each study.
6. **Appraise quality**: screening for exclusion, define criteria to exclude papers for insufficient quality. Development of a score for all included papers, depending on the research methodologies they employ.
7. **Synthesise studies:** includes analysis and combines the facts extracted from the studies using appropriate techniques (quantitative, qualitative or both).
8. **Write the review:** findings must be reported sufficiently so that other researchers can reproduce the results.

3.2 Identifying the Purpose of the Review

The first step of the SLR is to state its purpose clearly. This thesis uses the SLR to systematically identify actors (human and non-human) and their barriers. It will then be translated with ANT into the second actor network encounter of the MaaS business ecosystem. Thus, the progress of a specific research stream (MaaS business ecosystems) is analysed, and the results are put into a theoretical construct called an actor network. With that, RQ1 of this thesis will be answered by producing a comprehensive screening of literature and identifying a list of actors and barriers in the MaaS business ecosystem. Additionally, the results of this SLR are used to answer RQ2 by developing an actor network by investigating the translation process of the actors and identifying barriers in relationships through network analysis.

3.3 Literature Search Strategy and Selection Process

After the purpose has been stated, this section describes the data collection and search strategy, including the keywords and search terms which will be used. As this process needs to be transparent and explicit, Figure 6 highlights the literature search and selection process adopted, which will be applied in this section.

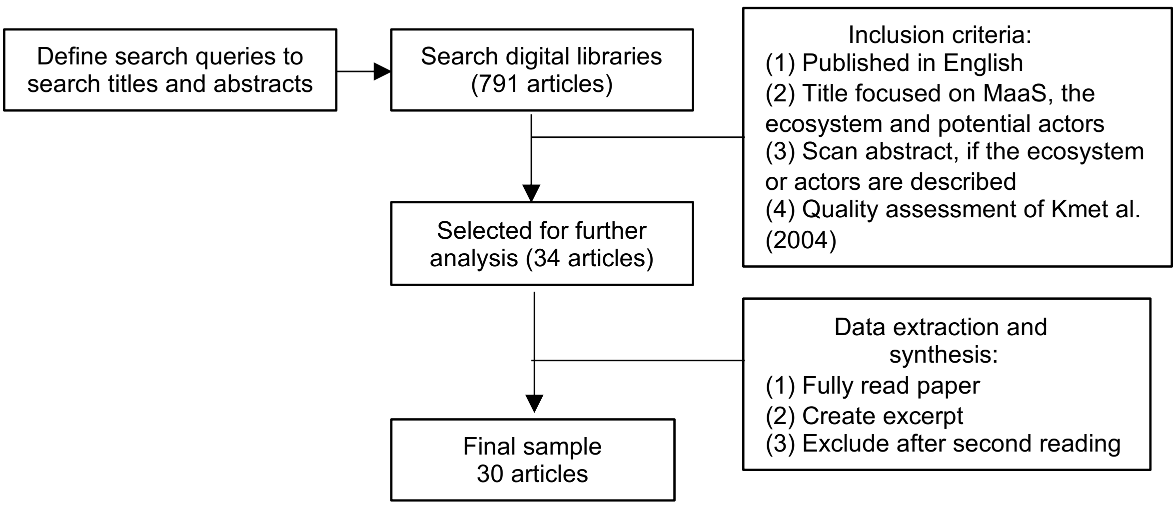


Figure 6. Literature Search and Selection Process (Gebhart et al., 2023)

The first step of the literature search and selection process is to define a search query searching for the titles and abstracts in databases. In particular, the data collection leverages open-access databases and specific subject databases. This thesis uses the following five digital platforms for the SLR: Google Scholar, IEEE Xplore, Scopus, EBSCO, and Web of Science. These sources help to get a descriptive overview of the potentially relevant scientific publications. Table 3 presents the search terms derived from this need.

Table 3. Literature Search Terms

Title Search Terms	Operator	Abstract and Text Body Search Terms
"Mobility as a Service"	AND	("actor" OR "barrier" OR "business ecosystem" OR "ecosystem" OR "network")
"MaaS"		

While the first search terms were used to search the titles, the second search terms were used to screen the abstract or body of the text automatically. Different search strategies, including search queries, had to be adopted for different online resources to conduct the initial automatic search. The complete process, including the individual search queries, can be found in Appendix A of this thesis. The initial database search yielded many results not directly related to MaaS, as the acronym is often used in other contexts and research disciplines. That is why in a second iteration of the search, only the written-out keyword: "Mobility as a Service" was used for searching the articles.

The second search iteration is shown in Table 4 and revealed 791 potentially relevant papers for this SLR.

Table 4. Total Number of Papers identified using the Search Terms

Digital Library	Number of Papers found by the Search Query
Google Scholar	438
IEEE Xplore	193
Scopus	69
EBSCO	58
Web of Science	33

3.4 Study Selection and Quality Assessment

This subsection highlights the study selection process and presents the inclusion and exclusion criteria. The study selection and quality assessment follows a three-step selection process. First, studies are selected based on selecting the title. In general, Okoli and Schabram (2010) suggest limiting the scope of the study. In the guide, there are ten criteria listed to reduce the scope and select relevant studies. This thesis filters studies by manually scanning the title, then the abstract and finally by a quality assessment.

Before the studies are selected using the inclusion criteria, the search results are combined into a list of 791 potentially relevant papers. This list serves as the basis for the study selection and quality assessment. In the first step, this list is sorted, and potential duplicates are removed. This resulted in removing 139 papers from the list. After that, 20 papers are excluded, which are not written in English. Then, a first content screening is performed to filter out papers not thematically related to the transportation industry and MaaS (336 papers). This leaves 296 papers to be further selected.

In the next step, the abstracts are read to refine the selection further. Here the papers are selected on multiple criteria. The focus is on scientific articles which are not including news, announcements, market analysis, demos, or country-specific implementations of MaaS. This supports the overall rigour of this study, while the study is limited to finding out the actors and their barriers in the MaaS business ecosystem. The title alone does not have enough information for some cases to select, so a second content screen has been performed. For those, the abstract is gathered, and the mentioned criteria are applied again. This procedure resulted in a list of 72 papers which are quality-assessed further.

Table 5 shows the inclusion and exclusion criteria which were applied.

Table 5. Inclusion and Exclusion Criteria

Part of the Paper	Applied Criteria
(1) Title	▪ Duplicate filtering: Potential duplicates by different searches are removed. ▪ Language filtering: The selected study should be written in English. ▪ Content filtering: The topic should be related to MaaS and the transportation industry.
(2) Abstract	▪ Content filtering: The study selection is limited to scientific papers. ▪ The paper's content (or, if readable, the title) should describe actors or barriers in the MaaS business ecosystem.
(3) Quality Assessment	▪ The selected papers are quality assessed according to the standard quality assessment criteria for evaluating primary research papers from a variety of fields of Kmet et al. (2004). ▪ The checklist for that has been attached in Appendix B.

Quality Assessment

The quality assessment is the final process step applied to assess the remaining studies. This step ensures that the selected papers have a certain quality to answer the research questions. Concretely, the quality assessment of Kmet et al. (2004) is applied, which is used to evaluate papers from a variety of fields with a set of standard quality assessment criteria. In this paper, the remaining 72 studies are quality assessed using the checklist for assessing the quality of qualitative studies. Each study is scored against ten criteria depending on the degree to which the specific criteria were met. The full list of the criteria and how the rating was done can be found in Appendix B of this thesis. During this process, “n/a” is not permitted for any items. The options available are “yes” = 2 points, “partial” = 1 point, and “no” = 0 points.

Consequently, a score is calculated by summing up the scores obtained across the ten items and dividing it by the maximum possible score, which is 20 (Kmet et al., 2004). Performing this task returns a quality score for each paper. These quality scores provide quantitative information on the relative quality of studies. As a next step, these quality scores are used for the evaluation by defining an inclusion threshold. This threshold is considered a minimum for including studies in the systematic review. The threshold considers the distribution of the quality scores, and a cutting point can be set conservatively at 75% or liberal at 55% (Kmet et al., 2004). In this thesis, the cut point was set conservatively at 75%, including 34 papers in the final data extraction.

Table 6 shows different cutting points which can be set using the quality-assessed papers and highlights the cutting point used in this paper.

Table 6. Possible Cutting Points for the Quality-Assessed Papers

Possible Cut-Points	Papers Included # (%)	Papers Excluded # (%)
<.55	66 (91,67)	6 (8,33)
<.60	63 (87,50)	9 (12,50)
<.65	58 (80,56)	24 (19,44)
<.70	55 (76,39)	27 (23,61)
<.75	**34 (47,22)**	**38 (52,78)**

While the quality score helped to create quantitative information on the quality of the studies, they can be used further in the SLR. One example would be to analyse differences within and across the study scores by synthesising information and exploring the homogeneity of the study results (Kmet et al., 2004).

3.5 Data Extraction

Finally, the data from the selected studies are extracted to provide the basis for the analysis and synthesis section. After the study selection and quality assessment process, there are 30 articles left that will comprise the final systematic review. Four additional papers were removed after second reading them. Okoli and Schabram (2010) state that systematic data extraction excerpts applicable information from each study. This means that for each of the selected studies, information is now collected that is considered important to be recorded to perform the analysis and synthesis of the SLR. This extraction prepares the selected papers to be multi-coded in the data analysis and synthesis chapter.

Table 7 shows an excerpt of the data items which are collected for the selected studies.

Table 7. Excerpt of Data Items collected for the selected Studies

#	Data Item	Description
1	Author(s), Date	Author(s) and published date of the article
2	Evidence, Type of the article	Conceptual or empirical
3	Objectives	Description of the objective of this paper
4	Findings and conclusions	Findings and conclusion

3.6 Analysis and Synthesis

After selecting, quality assessing and extracting data from the relevant papers, this subsection synthesis information of actors and their relationships out of the selected papers. For that, findings are extracted from the studies using appropriate methods (Okoli & Schabram, 2010). A helpful guide adopted in this thesis that introduces appropriate methods is called NVivo for Literature Reviews (O'Neill et al., 2018). Following this guide, a descriptive analysis is performed to get an overview of key-words and actors in the selected 30 articles. Figure 7 shows a word frequency cloud in which each word's size represents the word's frequency in the corpus. Several themes and actors can be identified from the word cloud, like users, technology, operators, and providers.

Figure 7. Word Frequency Cloud for selected MaaS Ecosystem Papers

After an overview of the literature has been created, the strategy of O'Neill et al. (2018) is followed by topic coding the literature with themes. For this thesis, the themes represent MaaS business ecosystem actors. The coding strategy first deductively uses the codes (actors) identified by Kamargianni and Matyas (2017) and then inductively allows new codes (actors) to come up from the literature.

Figure 8 shows this strategy. First, the codes are defined, and then the actors are coded in the papers. As a result, the actors in each paper are identified.

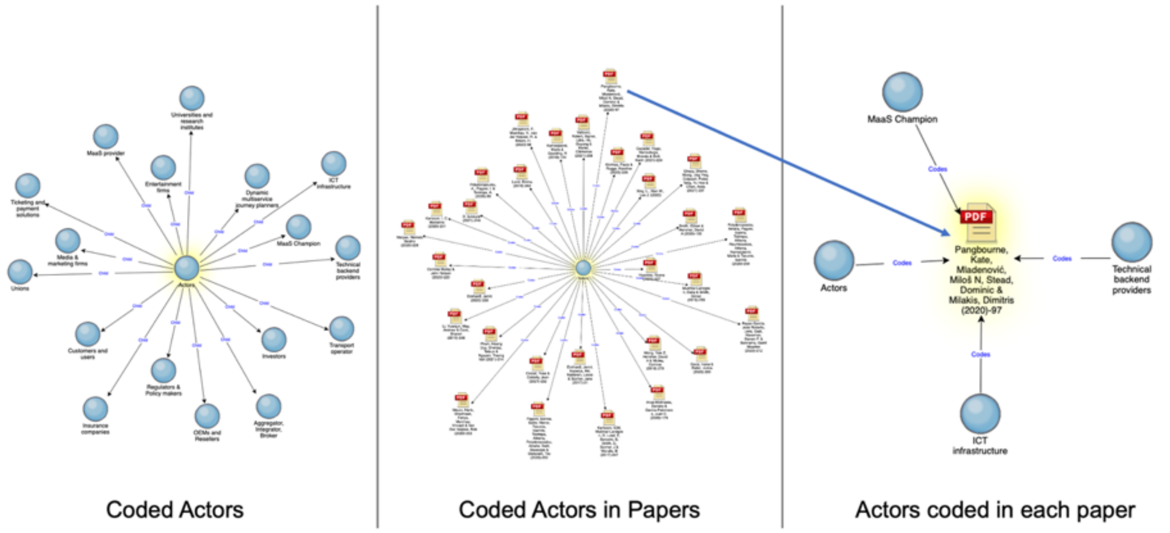


Figure 8. Coding Strategy for Analysis of Papers

From the initial codes, more codes have emerged from the literature. In total, 16 different actors with more sub-actors have been identified. Figure 9 shows a tree map of the coded actors in the selected MaaS ecosystem papers. Each coded actor is reviewed in detail in the next section.

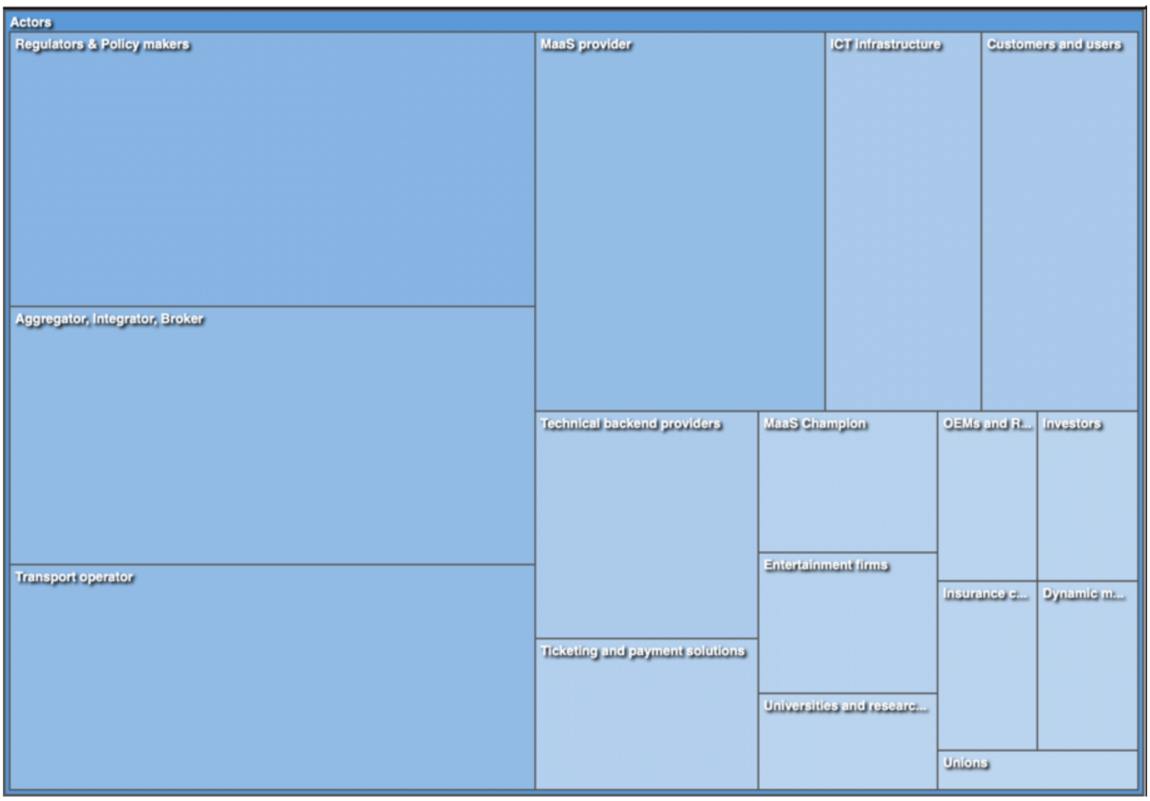


Figure 9. Tree Map of coded Actors in selected MaaS Ecosystem Papers

3.7 The MaaS Business Ecosystem Actor Network

Based on the actors coding results, this section builds up the second encounter of the MaaS business ecosystem actor network. First, different actors of the MaaS business ecosystem are identified, and the problematisation and interessement, including the OPPs to the focal actor, are described. Then the actors and their relationships, including barriers, are described in detail as part of the enrolment and mobilisation. After that, the second encounter of the MaaS business ecosystem actor network is inscribed. Finally, limitations and barriers are summarised and thematically grouped.

3.7.1 Identifying Actors in the MaaS Business Ecosystem

This subsection identifies actors in the MaaS business ecosystem. This is achieved by summarising the findings from the SLR. For that, the first two moments of translation are utilised, the problematisation and the interessement. The problematisation describes how the focal actor (MaaS provider) establishes itself as an OPP.

In the case of this thesis, the MaaS provider is the focal actor in the ecosystem and provides the platform as OPP by using platform technologies and Open APIs. The other actors in the MaaS business ecosystem all connect with the focal actor expressed through their OPPs. For example, the transport service operators supply private, public and logistics mobility services to the MaaS provider. The interessement describes the value proposition for each actor to join the network. For example, transport service operators can access a wider market, grow their revenue, and increase their market share by offering mobility services. This value proposition establishes the roles and power relationships in the actor network.

Table 8 introduces the main actors identified from the SLR and individually describes how the value is captured, what technologies are used, what the OPP is, and which authors introduced them.

Table 8. MaaS Business Ecosystem Actors identified from Literature

Actor	Interessement (How value is captured)	Dominant Technologies	OPP (Goals)	Key Authors
MaaS Provider	Being the focal actor, service offering, platform offering, franchise to different cities.	Platform technologies, Open APIs.	Offering the MaaS platform as focal actor.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020), Mulley and Nelson (2020), Eckhardt (2020)
Mobility Service Providers	Access a wider market, grow revenue, increasing their market share.	Service design, IoT, APIs.	Supplying private, public and logistics mobility services to the MaaS provider.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020), Mulley and Nelson (2020), Eckhardt (2020)
Aggregators, Integrators, Brokers	New markets for data brokerage services, data monetisation.	APIs, neutral server, data standards and protocols.	Providing data and analytics to MaaS providers.	Arias-Molinares and García-Palomares (2020), Mulley and Nelson (2020)
Customers and Users	MaaS adds value by enabling new forms of mobility.	Smartphones, connectivity, and payment.	Using mobility services over the MaaS platform.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020), Mulley and Nelson (2020), Sulskytė (2021)

Technology and IT Providers	Extra revenue through selling cloud infrastructure and compute services.	Cloud computing, big data, architecture.	Hosting IT infrastructure services and delivering architecture.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020)
Ticketing and Payment Solutions	Extra revenue for ticketing and payment.	Digital Wallet, NFC, payment platforms.	Offering digital wallet and payment services.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020)
Dynamic Multi-service Journey Planners	Intelligent planning of intermodal trips with data. Access of user data.	Data Processing, Data analysis, Machine Learning.	Providing intermodal planning capabilities to MaaS provider.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020)
ICT Infrastructure	Increase in revenue through using ICT infrastructure.	Communication technologies: 4G, 5G, WLAN.	Enabling the concept by providing connectivity infrastructure.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020)
Insurance Companies	New business opportunities, expanding the portfolio, revenue growth.	Insurances services, process modelling.	Offering policies for different mobility services to the MaaS provider.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020), Eckhardt (2020)
Regulatory Organisations	MaaS providers pay taxes and contribute to sustainable development.	Policy and regulation frameworks.	Provide and regulate open standards and interoperable data formats.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020), Mulley and Nelson (2020), Sulskytė (2021), Eckhardt (2020)

Investors and Funding Agencies	Exploit the MaaS market with funding.	-	Provide funding to emerging MaaS providers.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020)
Universities and Research Institutes	Create new insights and research into all aspects of the MaaS concept.	Diverse technologies depending on the aspect.	Generates new frameworks and insights for the MaaS provider.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020)
Media and Marketing Firms	Advertise the MaaS concept and grow revenue.	Marketing strategies and research.	Advertising the concept.	Kamargianni and Matyas (2017)
Unions	Fight for minimum standards and policies.	-	Providing authorisation for certain business models.	Kamargianni and Matyas (2017), Arias-Molinares and García-Palomares (2020)
Entertainment Firms	Extra revenue through offering supplemental services.	Servitisation	Providing supplemental services for MaaS providers and customers.	Arias-Molinares and García-Palomares (2020), Mulley and Nelson (2020)
The MaaS Champion	Leadership	-	Provides strong leadership to enable MaaS.	Mulley and Nelson (2020), Polydoropoulou, Pagoni, Tsirimpa, et al. (2020)

3.7.2 Extracting Key Relationships between MaaS Business Ecosystem Actors

In total, 16 key actors in the MaaS business ecosystem have been identified in the SLR. This subsection describes each identified actor in-depth and explains the actor's relationship based on the SLR findings. Thus, the codes of the selected papers are thematically compared and analysed within-case and cross-case (Eisenhardt, 1989). This process inscribes the second encounter of the MaaS business ecosystem.

MaaS Provider

The MaaS provider is the focal actor of the MaaS business ecosystem. In literature, the MaaS provider is often referred to as the MaaS operator or mobility service provider (Kamargianni & Matyas, 2017; Mulley & Nelson, 2020; Xing et al., 2019). The MaaS provider is in the middle of the ecosystem and integrates public and private mobility service providers, managing both demand and supply by offering mobility services to customers and dispatching mobility services to different transport operators (Arias-Molinares & García-Palomares, 2020; Pham et al., 2021). Thus, the transport and logistic service providers correspond to the supply side and the users and customers to the demand side (Reyes García et al., 2020).

Being at the heart of the MaaS business ecosystem, the MaaS provider manages the multi-actor environment and integrates and offers the best mode of travel in terms of time-saving, cost-saving, or customised settings into the MaaS platform (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020 ; Xing et al., 2019). Compared to traditional mobility services, the MaaS provider is one of the new stakeholders in the business ecosystem and offers the MaaS platform. This MaaS platform is a one-stop shop for offering and consuming integrated mobility services (Eckhardt, 2020).

Valkovic et al. (2021) state that the MaaS provider can be represented through a significant public transport provider, a new government agency, or even a public-private partnership, depending on the city context.

Eckhardt et al. (2017) describe two operator models for the MaaS provider, the reseller, and the integrator. In the reseller model, the MaaS provider acts as a broker and creates an interface through which end-users are offered mobility services. In contrast, the integrator model integrates supplemental services and features such as mobile ticketing and payment. This thesis formulates the MaaS business ecosystem from the perspective of the integrator model. The integrator model allows more flexibility in integrating different mobility services and allows the MaaS provider to be separate from the service providers. In particular, the integrator model has been described by Arias-Molinares and García-Palomares (2020) and Mulley and Nelson (2020). The role of an aggregator, integrator, or broker is widely seen in the literature as a separate actor, which will be described later in this subsection. Kamargianni and Matyas (2017) suggest that public transport authorities or private firms should take the role of a MaaS provider.

Currently, most public transport authorities are already responsible for authorising transport operators and could therefore take the role of the MaaS provider. In addition, public transport authorities are also taking the role of a transport regulator and, therefore, can offer all public transport services over a service. Further, public transport authorities might not have incentives or are constrained by law to develop MaaS services (Kamargianni & Matyas, 2017).

However, Crozet and Coldefy (2021) add that it might be out of scope for public transport authorities to develop MaaS services and that a skill gap exists for them as they need to become an IT services company.

Consequently, the bureaucracy of public authorities might slow down innovation penetration. Vice versa, private transport authorities have the skills to develop personalised services to optimise the travel experience (Valkovic et al., 2021).

One of the main goals of the MaaS provider is to set up an integrated mobility platform that serves as “value proposition” to the customer (Mulley & Nelson, 2020). Besides being of value to the customer, developing this platform requires strong partnerships with different transport operators.

Though, different goals of the transport operators lead to competition between the involved actors. This can lead to improved mobility services and issues like trusting each other (Polydoropoulou, Pagoni, & Tsirimpa, 2020). Therefore the MaaS provider needs to act as an entrepreneur and develop business models with all other actors to allow for a fair service design, revenue allocation and service level agreements (Mulley & Nelson, 2020).

Mobility Service Providers

Mobility Service Providers offer mobility services and provide the MaaS provider access to their data using APIs (Kamargianni & Matyas, 2017). Through selling their capacity and offering their service and data, transport operators have the opportunity to expand their markets, and more users will be using their mobility services (Arias-Molinares & García-Palomares, 2020). However, this also largely depends on the ability of the ecosystem to adapt. According to Mulley and Nelson (2020), multiple mobility service providers, both mode-specific and multi-modal, exist in a typical MaaS ecosystem. Eckhardt (2020) distinguishes three types of transport operators, public mobility service providers (municipal and long-haul), private mobility service providers (bike, car, ride, and taxi) and logistics service providers managing material flows between points of origin to end-use destination.

Li et al. (2019) add that each transport operator provides access to either a mobility asset or/and actual physical services, including public transport, airlines, road and parking or other infrastructure. The public mobility service provider offers all public transport-related services to the MaaS provider. Xing et al. (2019) highlight that the public transport operator should focus on operating and maintaining public transportation infrastructure and service. The quality of offering public transportation services should be assessed by a regulator with Key Performance Indicators (KPIs) and monitored by the MaaS platform of the MaaS provider. This regulation is needed to improve service quality and adoption from a user perspective. Depending on Service Level Agreements (SLA) the public mobility service provider and MaaS provider can negotiate contracts and travel fees.

As most public transport mobility service providers are cities' most relevant mobility providers, they are also considered the most preferred MaaS provider (Jittrapirom et al., 2020). However, implementing MaaS requires the physical infrastructure to be digitised and ready. For that, especially public transport mobility service providers need to develop a digital twin by IoTising and modernising their existing infrastructure (Ghazy et al., 2021). The term IoTising in that context means that the existing infrastructure will be equipped with sensors to collect real-time data (Internet of Things).

Private mobility service providers must work closely with public mobility providers to offer MaaS. Private mobility service providers offer individual services like taxis, carpooling, e-scooter and city bikes, flights, freight delivery and many more (Mulley & Nelson, 2020). The mobility service provider must include logistics services and other digital services like mobile ticketing, payment, multi-modal planners and intelligent routing (Eckhardt et al., 2017).

Those digital services are provided by digital service providers, which will be described in the next paragraph in detail. One crucial factor is the service design of mobility-related services, including parking, toll operators or electric vehicle charging infrastructure providers (Kamargianni & Matyas, 2017). Even individual citizens can potentially offer their vehicles to transport operators or MaaS platforms (Li et al., 2019).

For that reason, the mobility service provider owning and operating the mobility services needs a regulatory environment (Mulley & Nelson, 2020). Private mobility service providers must be regulated by limiting access to some providers or through geographic restrictions.

A MaaS provider can access a wider market and grow revenue and market share if the regulation works. Further, the mobility service provider can optimise the supply towards the MaaS provider by knowing the capacity and demand of each transport option (Kamargianni & Matyas, 2017). One requirement is that mobility service providers share their data and design open APIs, which allows the integration of different mobility services (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020). However, transport operators fear losing control and influence by losing their monopoly positions by participating in MaaS (Arias-Molinares & García-Palomares, 2020). Though, data analysis would benefit mobility service providers, as they can improve the offer, optimise the cost and provide better service to their customers (Valkovic et al., 2021). Concluding, MaaS has the potential for mobility service providers to establish new customer markets and efficiently operate transportation services (Gace & Babic, 2020).

Aggregators, Integrators and Brokers

The aggregators, integrators and brokers are part of the digital service providers, providing enabling technology solutions, applications and services to the transport operator and the MaaS provider (Eckhardt, 2020). The aggregator is the data broker that shares data and information to transport operators and the MaaS platform provider (Mulley & Nelson, 2020). Brokers combine heterogeneous mobility service data using standardised APIs and methods of data integration (Reyes García et al., 2020). Wong et al. (2018) describe the responsibilities of the broker to develop an interface of mobility contracts that brings together the services of the transport operators and other supplemental actors and their businesses.

In addition, the broker turns the basic services from the service providers into bundles to customers and users, who then purchase bundles with different subscription models (Wong et al., 2018). This is complemented through the integrator role, which combines the services of several modes with digital services. For some integrators, MaaS is considered their primary business; for others, it just complements their service offering (Eckhardt et al., 2017). Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) highlight that the integrator brings together multiple mobility service providers' offerings and offers the digital interface, APIs, and interoperability.

Different actors can take the role of an aggregator, integrator, and broker. It is likely that multiple integrators can coexist in the MaaS business ecosystem depending on their role (Li et al., 2019). Mulley and Nelson (2020) suggest that the role can be either performed on a commercial basis (marketplace between the MaaS provider and transport operators), by a single private transport operator, by a public transport operator, or by a public-private construct.

With that, regulatory organisations like that government must also interface with the MaaS aggregator and integrator broker (Wong et al., 2018).

In the work of Kamargianni and Matyas (2017) this actor is called a data provider and acts as key supplier to the MaaS provider by offering data and analytics capabilities. One important factor is that this actor needs to create business models depending on the demand for different transportation modes (Mulley & Nelson, 2020). To get this data, it needs to be available, standardised, and interoperable. Unfortunately, this is not the case. Ghazy et al. (2021) recognise that the current MaaS ecosystem is heterogeneous, and that data is only present in silos – standardisation and metadata necessary to enable data interoperability hardly exist. Other barriers have been described by Smith and Hensher (2020), including the quality of real-time information, incentives for data sharing, standardised APIs, platform architectures and security and privacy. These barriers are complemented by Gace and Babic (2020), who claim that transportation data is not open or shared, emphasising that openness and standardisation of data are necessary for MaaS development. In addition, Karlsson et al. (2017) raise the question of who should be responsible for the data, as data security and privacy needs to be addressed. Depending on the individual setup of the MaaS platform, this role will be taken by the aggregator, integrator, and broker actor.

As described previously, several actors need to collaborate and make their services and transportation data available (Kamargianni & Goulding, 2018). This requires a policy which ensures that traditional actors are not mistreated or that unequal agreements are established (Valkovic et al., 2021). Additionally, the data exchange must be beneficial for all actors contributing to the MaaS business ecosystem (Karlsson et al., 2017).

Customers and Users

The customers and users are core actors in the MaaS business ecosystem because MaaS is a user-centric model (Kamargianni & Matyas, 2017). The customer is consuming the mobility services the business ecosystem provides by booking the services or having subscription plans (Mulley & Nelson, 2020). The users can be private users like residents, visitors, tourists, or corporate customers (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020). Different users of MaaS do have different requirements for mobility services. Arias-Molinares and García-Palomares (2020) analysed those requirements. They highlight that market segmentation to target specific kinds of users with tailored mobility packages needs to become an important activity for the MaaS providers. Those tailored mobility packages need to be comprised of different plans combining transport modes, ticket prices and other supplemental services (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020).

Gace and Babic (2020) stress that the users of the MaaS business ecosystem expect MaaS to solve congestion problems and wait times and reduce their mobility costs. However, Kamargianni and Matyas (2017) first recognised that the customer's perception, attitude and acceptance need to change before they adopt MaaS. In this context, Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) suggest incentivising users to change their travel behaviour towards new digital mobility services. In contrast, Karlsson (2020) argues that MaaS just offers multimodal integration and reinforces already established travel behaviours rather than requiring significant behavioural changes. Valkovic et al. (2021) argue that those behavioural changes will automatically arise if the users learn to trust the MaaS platform provider to provide high-quality services, strong reputation and branding, high reliability and an easy MaaS app with a user-friendly interface ensuring high levels of convenience.

Sulskytė (2021) highlights that the users of the MaaS platform should be able to select the start and end points of the trip, specify their priorities and choose between criteria and other personal preferences. As a result, psychological and physical requirements impact user demands towards MaaS (Pham et al., 2021).

Users have in the MaaS business ecosystem the unique role of consuming and providing data. Eckhardt (2020) describes this as 'prosuming' mobility services. Through actively participating in the MaaS business ecosystem, users give information about themselves and their travels and provide feedback about mobility services (Matyas, 2020).

Technology and IT Providers

The next actors identified in the MaaS business ecosystem are technology and IT providers, initially introduced by Kamargianni and Matyas (2017) as technical backend providers. MaaS not only relies on a technical backend but also depends on IT workloads like applications, different technologies, and the hosting capabilities of hyperscalers. In that context, cloud services are at the core of the offering and generate extra revenue for IT providers. What is most important for MaaS is the usage of technologies and IT architecture. Considering technologies, mobile development of smartphone apps in combination with platform technologies becomes vital to provide mobility services to customers (Pangbourne et al., 2020). A requirement for both is open data standards and the usage of standardised APIs. From a technology perspective, blockchain technology with blockchain-based smart contracts has been proposed to enable the trusted transaction between the different actors in the MaaS business ecosystem (Reyes García et al., 2020). Chinaei et al. (2022) describe the usage of such smart contacts in the context of digital ownership.

ICT infrastructure (which will be described later) enables the usage of IoT technology. IT infrastructure applies all these technologies conceptually together and enables the MaaS platform, which the MaaS provider operates. This architecture needs to include data sources, modular services, an integration layer and a solution layer (Reyes García et al., 2020).

Ticketing and Payment Solutions Providers

Ticketing and payment solutions providers are actors of the digital service providers and supply the MaaS provider with trip planning and payment functionalities. Introduced first by Kamargianni and Matyas (2017), this actor combines technologies like digital wallets and offers a simplified ticketing and payment experience for users. This actor's main challenge is integrating different transport services into one ticket, as this largely depends on the transport operators ticketing technologies. Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) argue that a few operators only open booking, ticketing, and pricing data today. In addition, Kamargianni and Goulding (2018) state that mobile devices rely on a stable internet connection to access the MaaS platform for planning, booking and paying for trips. Technologies used by the ticketing and payment solutions provider include Near-Field Communication (NFC) terminals, QR-Codes and digital wallets (Kamargianni & Goulding, 2018; Polydoropoulou, Pagoni, & Tsirimpa, 2020).

Dynamic Multi-Service Journey Planners

Dynamic multi-service journey planners complement the digital service providers and provide trip-planning functionality for the MaaS provider (Kamargianni & Matyas, 2017). Arias-Molinares and García-Palomares (2020) add that this actor needs to promote intermodality while offering users an easy-to-use and customisable journey experience.

This requires the dynamic multi-service journey planners to have access to APIs of the transport operators and ICT infrastructure to provide real-time information about the trip (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020). These data sources, therefore, need to be open and standardised.

Information and Communication Technologies (ICT) Infrastructure

ICT infrastructure is a key actor in enabling MaaS. It provides internet connectivity (4G/5G, WLAN) for smartphones and IoT connectivity to get real-time data from the transport system (Kamargianni & Matyas, 2017). All the functionalities of the MaaS platform depend on this infrastructure. It includes data, ticketing, journey planning, payment, high-speed connectivity and data analytics (Arias-Molinares & García-Palomares, 2020). Pangbourne et al. (2020) state that ICT infrastructure is the baseline for developing the first MaaS platforms. An important concept which leverages and develops ICT infrastructure is the smart city concept. The development of MaaS will support the development of smart cities. This contributes to the accelerated development of cities, including new mobile communication standards like 5G and intelligent insights with artificial intelligence and automation (Valkovic et al., 2021). For example, offering electric mobility services requires a wide coverage of charging stations and electric grids (Reyes García et al., 2020).

Insurance Companies

Insurance companies will be part of the MaaS business ecosystem, as new insurance tariffs can for developed for the MaaS provider and the users (Kamargianni & Matyas, 2017). This creates new business possibilities, allowing them to expand their portfolio and increase their revenue (Arias-Molinares & García-Palomares, 2020). Developing insurance policies requires insurance companies to get deep insights into data generated by the users and collected by the MaaS platform provider.

This opens space for further research in which insurance companies can develop individual tariffs with different levels of protection in collaboration with the MaaS provider for sharing, rental, peer-to-peer and ridesharing services (Eckhardt, 2020). Developing such tariffs can include legal restrictions like passenger rights and compensation requiring regulation and policy (Murati, 2020).

Regulatory Organisations

Regulatory organisations are important actors in the MaaS business ecosystem. They are responsible for defining policies, rules, and regulations which need to be considered by other actors in the ecosystem, but most importantly by the MaaS provider (Kamargianni & Matyas, 2017). Regulatory organisations act at a distance with governance frameworks and policies. Such governance frameworks and policies are important to regulate the MaaS market but require a supportive legal environment which supports innovation (Sulskytė, 2021). Introduced by Kamargianni and Matyas (2017) named regulators and policymakers, they create value by defining regulations and policies that help for more efficient use of the current transport system.

Karlsson et al. (2017) distinguish between macro, meso and micro regulatory organisations. Pagoni et al. (2022) describe these as regulation levels that can happen at the EU (worldwide), national and local city levels.

The macro level consists of political and societal institutions that can be either national or international. On this macro level, international organisations, governments, and legislation define standards, laws, regulations, and policies for implementing MaaS. One example is the MaaS alliance which has formed as an international organisation to define standards and protocols for MaaS.

The government's role is to collaborate among the actors managing difficult issues such as data security, price or user protection by law (Gace & Babic, 2020). In addition, legal and regulatory frameworks and policies like passenger rights, personal data protection, competition rules, data standards, ticketing, and payment standards need to be considered on this level (Pagoni et al., 2022).

These legislation processes can then be considered on a national or local authority level, resulting in better preconditions for MaaS development (Eckhardt, 2020). With these processes, political actors act from a distance by specifying the enabling rules of the MaaS market (Matyas, 2020). Further, authorities ensure fair competition, privacy security and service quality (Arias-Molinares & García-Palomares, 2020). Authorities own the legislation and ministries and have control over road authorities. They coordinate transport policies, permits, licenses and infrastructure investments (Eckhardt, 2020).

One key barrier is that national governmental organisations need to ensure that no legislature-based obstacles are preventing the development of MaaS (Haavisto & Mladenović, 2020). To overcome that, they need to actively participate in dialogue with the different actors at networks and forums to remove potential obstacles. Further, national government regulators must set up rules for sustainability practices that MaaS platform providers can integrate. Thus, they balance public and private interests through negotiation with the actors and legislation (Guyader et al., 2021). Mulley and Nelson (2020) describe the role of authorities on a national level as a facilitator between different actors, which needs to provide multi-level governance that can be applied to different contexts. Continuously, the government must ensure that mobility services can be improved and support long-term network planning (Valkovic et al., 2021).

For example, in Finland, the Ministry of Transport and Communications developed a national MaaS framework around a digital transport code, encouraging new digital business models and MaaS services by requiring public transport operators per law to use electronic channels (Mulley & Nelson, 2020). This behaviour is needed to make MaaS a reality and is described later as the MaaS champion.

In addition to worldwide and national regulatory bodies, local authorities play an essential role in MaaS. Karlsson et al. (2017) describe the local authorities as meso level, having a formal dimension that includes policies and regulations and an informal dimension which includes collaboration and partnerships. Eckhardt (2020) states that those local authorities are responsible for regional and municipal public transport and are therefore responsible for opening their public transport interfaces and data to enable MaaS. Regional authorities engage in strategic planning and development of municipal and cities and traffic planning (Reyes García et al., 2020). Therefore, city authorities have a better view of specifics when formulating policies to improve infrastructure and urban planning (Valkovic et al., 2021). In agreement with government authorities, the local authorities must establish a citywide mobility vision, including a strategy to develop a supportive regulatory framework (Valkovic et al., 2021).

Finally, there are individual citizens, which are referred to as customers and users of MaaS, that follow the regulations on a micro level (Karlsson et al., 2017). While on a micro level, no regulations are formulated, the users of MaaS can influence the development in multiple ways. One way is through unions, organised worker councils and legal fights. Such unions can help to develop regulations and policies with specific quality standards (Kamargianni & Matyas, 2017).

Unions can slow down the MaaS development by overregulating the market and protecting traditional business models of transport operators, which could be disrupted by new MaaS business models (Kamargianni & Matyas, 2017). Conversely, unions can establish fair competition regulations to be open to MaaS (Arias-Molinares & García-Palomares, 2020).

In conclusion, different policy mixes will be required, and there needs to be experimentation with policies and institutional change (Kivimaa & Rogge, 2020). For that change, government authorities must support the city's population with policies for end-users and sustainable commercial mobility options underpinned by regulated technological innovations (Valkovic et al., 2021). These policies must be enforced by regulatory measures and laws and written down in a governance framework. This governance framework needs to be consistent and appropriate on worldwide, national and local levels (Pagoni et al., 2022). Further, the governance framework needs to be monitored and validated continuously to ensure transparency, fairness and openness amongst the different actors in the MaaS business ecosystem (Valkovic et al., 2021).

Investors and Funding Agencies

Investors and funding agencies are exploring the MaaS market and fund arising MaaS platforms (Kamargianni & Matyas, 2017). Investors can also be the governments that can invest through subsidies and other investments. Governments can expect to invest in the MaaS business ecosystem to reduce congestion, optimise city spaces, and make them more sustainable and modern (Gace & Babic, 2020). Eckhardt (2020) names the legislator and ministries as central actors for funding as they engage in transport policies, strategies, and infrastructure investments.

While in some countries, a centralised approach for developing MaaS and the business ecosystem exists. For example, in Australia, the government funds start-ups through MaaS innovation challenges (Mulley & Nelson, 2020).

Universities and Research Institutes

Universities and research institutes play an essential part in the MaaS business ecosystem, supporting its development by researching different parts of MaaS (Kamargianni & Matyas, 2017). Concretely, universities and research institutes develop new knowledge based on evidence from investigating MaaS platforms for obtaining new decision-making tools and strategies (Arias-Molinares & García-Palomares, 2020). For example, universities and research institutes can enable regulators or other actors in the MaaS business ecosystem to develop an appropriate framework, research different technological innovations, and define new business models, insurance concepts or financing structures (Kamargianni & Matyas, 2017). Research in the domain of MaaS is vital for the concept to flourish and to provide sustainable, technology-driven mobility services in cities as well as in rural areas (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020).

Media, Marketing, and Entertainment Firms

Media, marketing, and entertainment firms are advertising MaaS and offering third-party services to introduce the concept to a broader audience and increase the users' acceptance (Kamargianni & Matyas, 2017). They mobilise the MaaS business ecosystem to get more actors on board. Therefore, entertainment firms offer services beyond mobility (Mulley & Nelson, 2020). These non-mobility services are embedded as experience during or after the trip including subscription packages for free Wi-Fi, access to newspapers or magazines, and discounts for restaurants or coffee places (Arias-Molinares & García-Palomares, 2020).

In addition, by partnering with MaaS actors, vouchers or coupons can be offered, which can be redeemed in stores during or after the trip (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020). Xing et al. (2019) add the possibility of personalising such services depending on the customer's preferences, creating a new mobility experience. Further, advertisements can be placed in the mobile apps, which serve as an additional revenue channel for the MaaS service provider.

Original Equipment Manufacturers (OEMs) and Resellers

OEMs and resellers are extended actors of the MaaS business ecosystem. They are responsible for producing and offering a sustainable fleet for MaaS by integrating the latest technological innovations into their products (Eckhardt, 2020). OEMs can partner with actors in the business ecosystem to promote their new vehicles and technology and enable the servitisation of mobility services by participating in developing carsharing, rental and leasing services (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020).

The MaaS Champion

The MaaS champion provides strong leadership amongst the actors participating in the MaaS business ecosystem. The MaaS champion manages and resolves tensions among the actors by providing clear leadership and focus during the MaaS business ecosystem enrolment process (Guyader et al., 2021). However, the actors who can serve as MaaS champions are not well-defined (Mulley & Nelson, 2020). Smith and Hensher (2020) suggest that regulatory organisations or transport operators can take over this role. Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) argue that the MaaS champion depends on the context in which the MaaS is established.

In the context of ANT, the MaaS champion can be seen as the leader of an alliance of actors who contributes to the success of MaaS and does not abuse its power advantage (Meurs et al., 2020). Thus, the MaaS champion helps the diffusion and timely development of MaaS by minimising uncertainties and slack among the actors (Guyader et al., 2021). One example of a MaaS champion is the EU MaaS Alliance, founded in 2015 and encouraged public-private partnerships to promote MaaS by defining standards and regulations (Pangbourne et al., 2020).

Strong collaboration amongst the actors in the MaaS business ecosystem is of vital importance. In a recent study by Jittrapirom et al. (2020), the findings underline this importance, and the study panel suggests researching more pilots of MaaS to learn how collaboration can be increased. Smith and Hensher (2020) discover that a MaaS champion can overcome institutional barriers that hinder the diffusion of MaaS.

To let the MaaS partnerships develop, Smith and Hensher (2020) suggest that the public sector needs to transform in terms of internal organisation, innovation management and human capital. The diversity of the actors in the MaaS business ecosystem asks for new process models and tools for public-private partnerships (Mukhtar-Landgren & Smith, 2019). One example of success has been the northern countries where the transport ministries are building transport codes, which require the public sector to digitise their services by law (Mulley & Nelson, 2020). This emphasises that solid collaboration between the different business ecosystem actors is critical for developing MaaS (Jittrapirom et al., 2020).

3.7.3 Constructing the Second MaaS Business Ecosystem Actor Network

After the different actors of the MaaS business ecosystem have been identified and analysed through the SLR, this subsection presents the second encounter actor network of the MaaS business ecosystem. From this actor network, barriers in the MaaS business ecosystem are summarised from the relationships and descriptions of the individual actors. These barriers serve as requirements for the empirical part of the thesis, which will be introduced in the next chapter. In addition, this subsection shows how the actor network, barriers, and empirical findings can amend existing research gaps. Figure 10 presents the second encounter of the MaaS business ecosystem, generated based on the SLR and descriptions of the previous subsection.

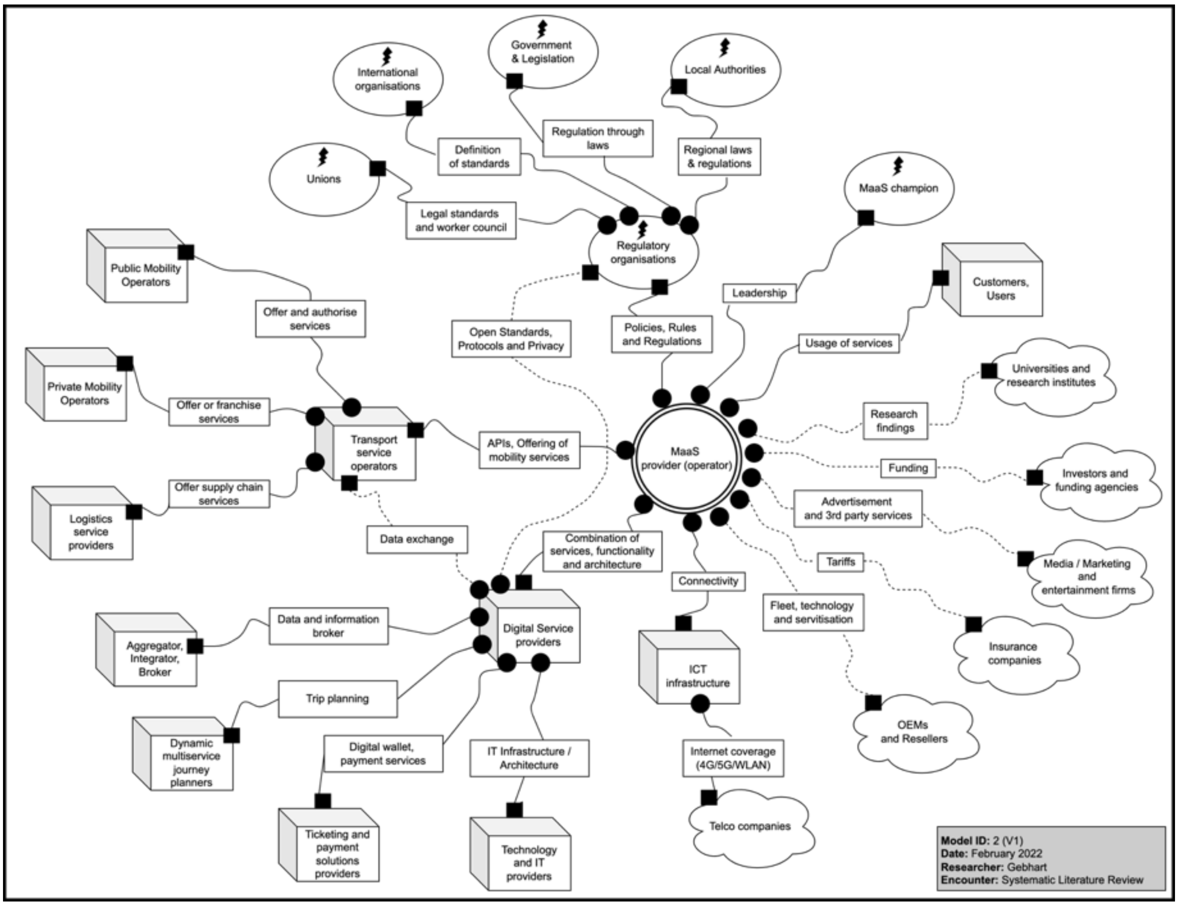


Figure 10. Second Encounter of the MaaS Business Ecosystem (Gebhart et al., 2023)

Comparing the second encounter with the first one developed based on Kamargianni and Matyas (2017), it becomes clear that the constellation of the actors has changed since then. The SLR renamed and detailed existing actors and revealed new actors, which generated new insights into the current formation of the MaaS business ecosystem.

Through detailing the actors in the actor network, it became visible that alliances were forming. Thus, the actors can be grouped into “core”, “acting from a distance”, and “influencing the network”. This concept of forming alliances in MaaS has been first observed by Meurs et al. (2020), describing MaaS as an alliance of partnering firms. Further, mapping the actors in the MaaS business ecosystem made it clear that actors can take over multiple roles. First MaaS pilots indicated that, for example, Uber could produce its data as a data provider while offering mobility car services as a mobility service provider (Li et al., 2019). While companies can take multiple roles in the ecosystem, they are all experiencing the same barriers hindering innovation diffusion.

3.7.4 MaaS Barriers and Research Gaps

After researching how MaaS can be conceptually defined, the SLR revealed actors and their relationships in the MaaS business ecosystem. In these relationships, barriers were introduced. This subsection details those barriers by grouping them thematically and working out research gaps. In order to work out the different gaps, the papers from SLR have been coded for keywords, and the findings have been summarised into three key areas, which will be discussed in this subsection. Here, the technical, sociological, and economic themes for designing MaaS services of Christiaanse (2019) served as an initial classification for the emerging barriers.

Figure 11 illustrates the current key authors in the field, clustered in three main areas that have been identified: technology and data (green), social and cultural (red), and policy and regulation (blue). For each author, the research focus and the gap are presented. Here, the author is put on a continuum between the three identified research areas represented as mixed colours.

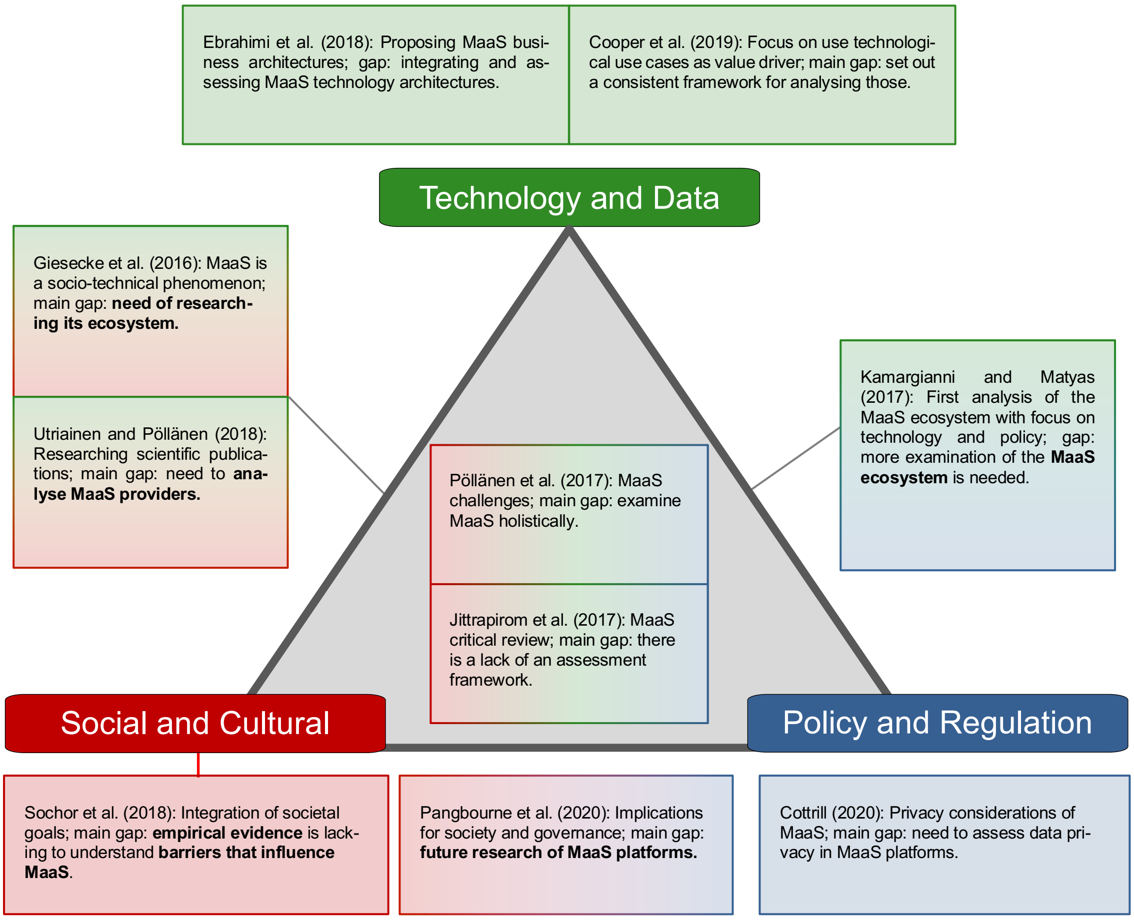


Figure 11. Key Authors and Research Gaps in three Areas

Technology and Data (TD)

When it comes to technology and data, one significant challenge is designing a platform that is very scalable and available all the time. Pangbourne et al. (2018) recognise that although MaaS promises new ways of mobility freedom, it can also cause severe problems if the platform runs out of capacity or has no option to use MaaS services.

This example shows a high technology dependency and naturally leads to the question of using MaaS in not so developed regions and countries. As a result, Pöllänen et al. (2017) argue that a MaaS platform should include valid operational models also for rural areas. These operational models often fail as rural IT infrastructure and connectivity are not yet established (Ebrahimi et al., 2018). Here, Szmelter (2018) observed that there are still too few research results on MaaS development, especially in IT. This gap is underpinned by Ebrahimi et al. (2018), who identify business architectures as the key enabler for offering mobility services. Such business architectures rely on a network of actors. Cooper et al. (2019) express that such a network requires collaborative mechanisms and indicate that a framework for analysing the technological actors and business architectures is needed.

Social and Cultural (SC)

As many actors are part of a MaaS platform, a key challenge is that the MaaS practitioners have to prove that their business strategies and practices will not influence other's customer base and brands (Sochor et al., 2018). Key actors increasingly fear losing customers to other service providers and losing their brand image and customer relations if everything is handled by one platform (Nguyen et al., 2019). Thus, new business models must be implemented, leading to a win-win situation for all actors involved. Besides that, a cultural change and willingness to co-create are required. A cultural change must happen with the consumers, as they need to be ready not to own, for example, personal cars anymore and instead consume their mobility through a service (Pangbourne et al., 2020). Here, the key challenge is the adoption of MaaS (Pöllänen et al., 2017).

Considering that adoption will happen sooner or later, a big social question arises. Can everybody afford or can use MaaS? Will there be a “one price fits all” policy?

These challenging points need to be addressed to prevent social exclusion. As MaaS relies on registration and technology, everybody in society needs to have a chance to use it (Pangbourne et al., 2018).One significant gap identified by Sochor et al. (2018) is that empirical evidence lacks which barriers influence the development of MaaS, especially in the social and cultural areas. In addition, Pangbourne et al. (2020) outline that gaps in framing MaaS platforms and policies exist, and therefore future research is required. In that context, Pangbourne et al. (2020) highlight that for policy-framing the actors of MaaS, it is necessary to understand the distribution of roles and responsibilities in the business ecosystem.

Policy and Regulation (PR)

MaaS needs to be tailored to different areas and obey different laws and regulations in countries (Pöllänen et al., 2017). That is why Kamargianni and Matyas (2017) suggest developing individual policy frameworks on the country level, which the government should approve. The challenge here is to maintain momentum when scaling MaaS. Each country's laws are different and therefore require a customised policy. As a result, Kamargianni and Matyas (2017) suggest that MaaS creates an international organisation that agrees on open standards for MaaS.

Pagoni et al. (2022) reviewed existing European regulation and policy frameworks. They observed that more case studies are required to identify potential challenges and to outline the MaaS concept. Another challenge highlighted by Lundqvist and Murati (2020) will be to analyse the actors of MaaS from a competition law perspective. Additionally, Cottrill (2020) highlights the need to develop policies concerning GDPR. For both challenges, an accurate mapping of the business ecosystem of MaaS is a requirement.

Identified Barriers in the MaaS Business Ecosystem

The barriers identified from describing and analysing the actors in the SLR are introduced in Table 9. These are thematically grouped by the previously introduced themes and are underpinned by the authors who introduced them in literature. While these barriers have been developed from literature, practical empirical evidence is lacking if and how these barriers are experienced in the field and how they block the diffusion of MaaS. These present a research gap as MaaS business ecosystem actors seek advice on unblocking potential barriers.

Table 9. Barrier Themes with Authors for Empirical Case Study Research (Gebhart et al., 2023)

Identified Themes	*Factors (Barriers)*	*Authors*
Technology and Data (TD)	*(TD1) Data Security and Privacy*	Gace and Babic (2020), Smith and Hensher (2020), Cottrill (2020), Huang (2022)
	(TD2) Lack of Openness of Data, Standardisation, Data Silos, and Interoperability	Polydoropoulou, Pagoni and Tsirimpa (2020), Ghazy et al. (2021), Gace and Babic (2020), Karlsson et al. (2017), Kamargianni and Goulding (2018), Servou et al. (2023)
	(TD3) Modernisation of ICT Infrastructure, Internet Coverage, Real-Time Information Available	Ghazy et al. (2021), Smith and Hensher (2020), Kamargianni and Goulding (2018), Hasselwander and Bigotte (2022)
	(TD4) Unclear or No Platform Architectures Existing	Smith and Hensher (2020), Reyes García et al. (2020), Zhou et al. (2023), Yano et al. (2022)

Social and Cultural (SC)	*(SC1) Acceptance of Users, Travel Behaviour, Lack of User Trust*	Kamargianni and Goulding (2018), Alonso-González et al. (2017), Polydoropoulou, Pagoni, Tsirimpa, et al. (2020), Karlsson (2020), Valkovic et al. (2021)
	(SC2) Competition, Losing Monopoly Position, Control, and Influence	Arias-Molinares and García-Palomares (2020), Karlsson et al. (2017), Alyavina et al. (2022)
	(SC3) Difficulties for Users Related to Technologies	Arias-Molinares and García-Palomares (2020), Alonso-González et al. (2017), Smith et al. (2022)
	(SC4) Missing Collaboration	Smith et al. (2019), Arias-Molinares and García-Palomares (2020), Karlsson et al. (2020)
	(SC5) Missing Leadership and Vision	Valkovic et al. (2021), Mulley and Nelson (2020), Smith and Hensher (2020), Guyader et al. (2021), Meurs et al. (2020)
	(SC6) Skills and Knowledge Gaps	Crozet and Coldefy (2021), Smith and Hensher (2020), Kayikci and Kabadurmus (2022)
Policy and Regulation (PR)	*(PR1) Demand Estimation, Creation of Business Models, Tailoring of Services*	Mulley and Nelson (2020), Arias-Molinares and García-Palomares (2020), Turoń (2022)
	(PR2) Legal Issues, Bureaucracy, and Institutional Barriers	Kamargianni and Matyas (2017), Murati (2020), Pagoni et al. (2022), Smith and Hensher (2020), Kivimaa and Rogge (2022)
	(PR3) Poor Governance Frameworks, Policy, and Regulation Challenges	Karlsson et al. (2017), Jittrapirom et al. (2020), Arias-Molinares and García-Palomares (2020), Mulley and Nelson (2020), Haavisto and Mladenović (2020), Tabascio and Brail (2022)

3.8 Conclusion and Gap Statement

Figure 12 concludes this chapter by showing the research process followed in the last two chapters of this thesis. First, MaaS has been researched in its academic context by reviewing definitions, characteristics, limitations, and challenges. Then, a conceptual understanding of this thesis around the MaaS business ecosystem has been established, for that ANT and the basic MaaS business ecosystem understanding of Kamargianni and Matyas (2017) helped to conceptualise the first MaaS business ecosystem actor network. Through systematically identifying actors in the MaaS ecosystem, actors' relationships and experienced barriers were extracted. As a result, the actor network of the MaaS business ecosystem, in combination with the extracted barriers in the network, now serves as the theoretical and conceptual basis for further empirical research.

The SLR-identified barriers exist for MaaS in the areas of technology and data, social and culture and policy and regulation. Christiaanse (2019) also recognises these areas and describes that MaaS services are technical, economical, and sociological. Initial characteristics of MaaS and conceptualisation have been proposed by Giesecke et al. (2016) and Jittrapirom et al. (2017). These practical insights made it clear that MaaS platforms must take an integrated approach and that gaps in each area must be filled. In addition, the SLR showed that identification and mapping actors of the MaaS business ecosystem are essential to close the research gaps in each area. This results in the following gap statement:

Gap Statement*: The literature review revealed a lack of empirical evidence on the implementation of MaaS and the barriers faced by the providers.*

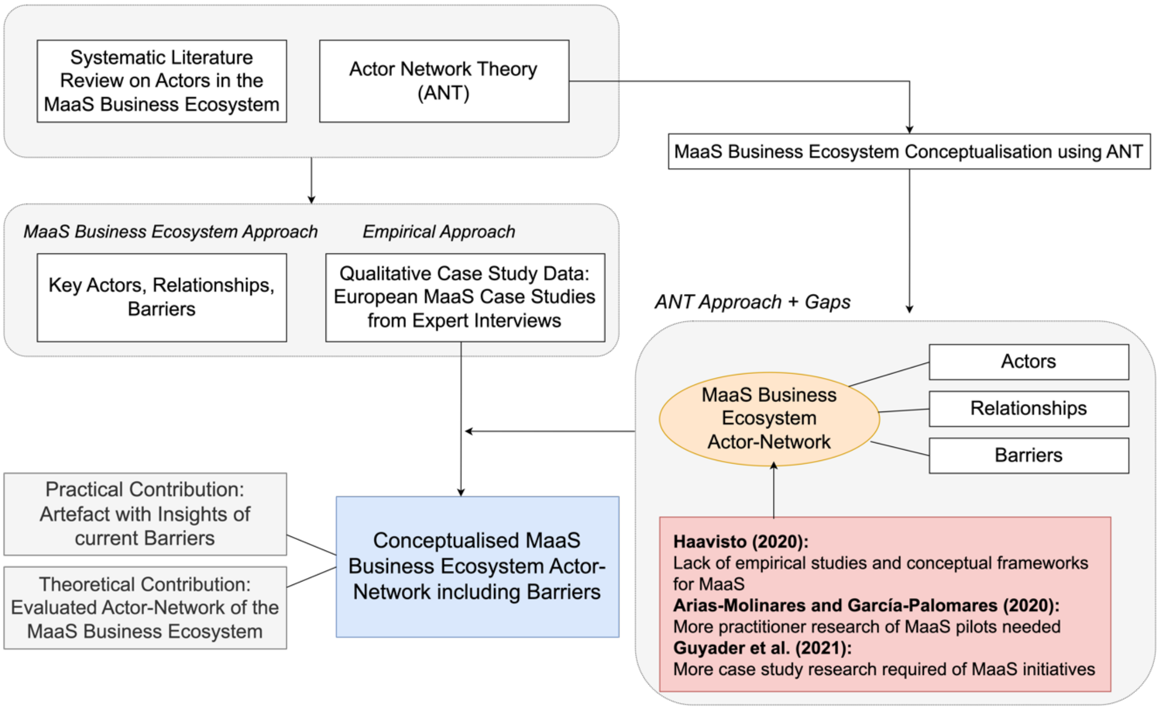


Figure 12. Amending the MaaS Actor Network with Empirical Findings (Gebhart et al., 2023)

This gap statement is underpinned by Haavisto and Mladenović (2020, p. 857), who state that "we have to recognise that transport research lacks both similar empirical studies and lacks operationalised conceptual frameworks from philosophy and sociology of technology".

Consequently, Arias-Molinares and García-Palomares (2020, p. 262) conclude that the "main challenges lying ahead are to promote new MaaS pilots to gain more data and develop more research". Here, Smith et al. (2019, p. 131) asks for "additional studies of both the same case in later stages of the development of MaaS, and of heterogenous sets of other cases […] to better understand the development of MaaS and for broadening the understandings of the barriers".

In particular, Guyader et al. (2021, p. 17) emphasise that "more case studies on the interplay between institutional logics in MaaS initiatives from other markets are a valuable contribution to the discussion".

Pagoni et al. (2022, p. 7) adds that “since MaaS is continuously gaining ground in the mobility system, demonstration of new schemes and collaboration of new players is expected […]” that “should be creating opportunities for further experiments and studies regarding MaaS, aiming to better identify potential challenges”. Finally, Karlsson et al. (2020, p. 293) point out that “beyond contextual differences, this also includes a call for studies of barriers and enabling factors in later phases of the development and implementation of MaaS”.

The next chapter will address these gaps by collecting primary case study data on barriers in the MaaS business ecosystem from the perspective of MaaS platform providers. Thus, the practical application of ANT in combination with the MaaS business ecosystem will be studied in European MaaS implementations. This case study research will raise the awareness of platform builders towards the MaaS business ecosystem and give them an artefact to build their business ecosystem network. Through that artefact, they can generate actionable insights to overcome existing barriers in their actor network. The evaluated MaaS business ecosystem actor network artefact will uncover new relationships, barriers, and actors, which will amend existing academic literature.

Parts of this chapter and the following chapters have been published by the author of this thesis and were cited accordingly (Gebhart et al., 2023).

4 Research Methodology

The research methodology chapter is divided into five sections. The four elements of Crotty (1998) have been adopted to structure the following sections. Thus, epistemology informs the theoretical perspective, which in turn guides the methodology, ultimately governing the choice and use of methods. Section 4.1 introduces the research philosophy and explains the ontological, epistemological, and axiological perspectives adopted by this thesis. After that, Section 4.2 presents and justifies the chosen research design. Here, it is explained how design science and case study research enable the evaluation of barriers. Then, Section 4.3 describes how the research design is operationalised. Next, Section 4.4 details the research approach by presenting the case study protocol. This protocol contains the data collection procedures, data analysis and presentation, quality criteria and ethical considerations. Finally, Section 4.5 concludes this chapter to prepare for the results chapter.

4.1 Research Philosophy

The introduced MaaS business ecosystem actor network, in combination with the identified relationships and barriers, serves as the foundation to gather and investigate the MaaS business ecosystem in its practical context. To further research the MaaS business ecosystem, it is essential to understand which research philosophy is adopted. According to Saunders et al. (2016), research philosophy refers to a system of beliefs and assumptions which encounters reality (ontological), how the knowledge can be gathered (epistemological) and how the values of the researchers influence the research (axiological). The following text presents these underlying assumptions.

Ontological Assumptions

The ontological assumptions determine how the researcher studies and researches the research object (Saunders et al., 2016). While five major research philosophies exist, these research philosophies range between two opposite ends: objectivism and subjectivism (Niglas, 2010). From an objectivist point of view, social entities exist independently of how we think of them, and interpretations and experiences do not influence their existence (Burrell & Morgan, 1979). On the other end is subjectivism, which describes that social reality is purely based on people's perceptions and actions (Saunders et al., 2016).

This research shows that MaaS cannot be defined as an external object without a social reality (Arias-Molinares & García-Palomares, 2020). MaaS and its business ecosystem must be seen as a constructed term or phenomenon which offers a digitalised approach to consuming mobility services (Jittrapirom et al., 2017). Interpretivism and particularly constructivism describe that reality is constructed and interpreted through social interactions (Saunders et al., 2016). Adopting this philosophical stance helps to research the MaaS business ecosystem. Through the previous chapters, it became evident that the ontological reality of MaaS is fuzzy. For that reason, a common understanding of the term MaaS and its business ecosystem has been established.

Seeing MaaS without a social reality will not work, as the MaaS actors are not only technical but also human. Latour (2007), founder of ANT, argues that mainstream philosophy's ontology wonders whether things exist independently from us or if our human minds construct them. ANT undermines the power of association and embarks that objects are not just constructed by human minds but also by multiple technical and non-technical actors who are equally real (Latour, 1984).

This view of the power of association is shared by other authors like Jean Baudrillard, who describe representation as being more important than reality. In his book "Simulations", Baudrillard (1983) states that society has become reliant on models and maps which have lost contact with the real world. Therefore, he examines relationships between reality, symbols, and society. His work describes simulacra as copies without a reality underneath and simulation as the imitation of a real-world process.

Additionally, Baudrillard (1983) describes three "orders of simulacra"; the pre-modern order in which the image is recognised as an illusion. The second industrial order is where the image and its representation begin to break down. The third post-modern order is in which there is no distinction between reality and its representation. Concerning this thesis, MaaS and its business ecosystem can be seen as emerging simulacra representing and structuring an underlying social and technical reality. Baudrillard (1983) argues that media culture, multinational capitalism, urbanisation, language, and ideology are responsible for replacing reality and meaning with symbols and signs. MaaS and its business ecosystem are mainly enabled through the same concepts, including media culture, urbanisation, and technological advances. Researching it requires an ontology that accepts objects and actions as equally real as concepts defined by our mind. For this reason, a conceptualised actor network of the MaaS business ecosystem serves as ontology.

Considering Critique of ANT and its Flat Ontology Assumptions

In the context of this study, it is important to consider the underpinning flat ontology assumptions made by adopting ANT. A flat ontology challenges hierarchical distinctions between entities and acknowledges the existence of both human and non-human actors on an equal ontological plane.

Adopting this ontological plane requires a balanced critique of the strategy, drawing on insights from various philosophical perspectives and contributing to a broader philosophical discourse.

Latour (1999), the founder of ANT, critiqued ANT, challenging the hyphenated connection between 'actor' and 'network' and the related agency/structure dichotomy, leading to misunderstandings. Further, Latour (1999) concludes by addressing the difficulties associated with the term 'theory' in ANT, emphasising that it is not a social theory but a method to learn from actors without imposing predefined categories. Still, he suggests that ANT has the potential to explore the spaces "in-between" network trajectories. Reflecting on this, that is precisely the point for which ANT will be used in this thesis. This research is interested in investigating the relationships of the actors in the MaaS business ecosystem to understand the barriers they face.

Adding to this, Graham Harman, a prominent philosopher associated with Object-Oriented Ontology (OOO), critiques the reduction of entities to mere actors in a network. Harman (2009) argues that entities have an essence that exceeds their relational interactions. For that, he challenges the ANT of Latour and other prominent philosophies like the Process Philosophy of Whitehead (1979) or the Phenomenology of Husserl (2001) and Heidegger (1962) for reducing the entities in a network to their relations or human access. By forming the philosophy of Speculative Realism and Object-Oriented Ontology, Harman (2018) insists on the existence of autonomous objects above and apart from human access or interest. However, Harman (2013) states that he defines objects in such a way that Latour’s actors also count as “objects” in the widest sense.

Considering this perspective, a different understanding of objects is crucial as they are inaccessible and hidden from reality and cannot be interacted with.

As a result, the researcher recognises that the flat ontology assumptions in the MaaS business ecosystem might oversimplify the complex nature of underlying hidden objects. However, the researcher is interested in understanding the human and non-human (for example IT-Systems) actors in the MaaS business ecosystem by investigating their social networks and relationships. This approach promises a deeper understanding of social phenomena MaaS. Therefore, besides the flat ontology assumptions made by this study, the ANT approach offers a powerful lens to analyse barriers in the MaaS business ecosystem.

Epistemological Assumptions

Epistemology details which knowledge constitutes valid and legitimate knowledge within one research philosophy (Saunders et al., 2016). Adopting a constructivist epistemology means scientific knowledge is generated through experiences and context-specific conversations (Eatough & Smith, 2007). The research questions of this thesis are interested in researching the MaaS business ecosystem in its practical context. Thus, the data gathered will be based on case-specific opinions and narratives of MaaS implementations. Each implementation of MaaS is context-specific, so the study participants will see the reality differently. Being a constructivist helps account for the different realities in which the multiple actors of the MaaS business ecosystem are living (Saunders et al., 2016).

Considering the Researcher’s Bias with Axiological Assumptions

However, when doing research, the researcher has to collect and understand information from different actors in the MaaS ecosystem. During this process, it is impossible for me (as the researcher) to completely separate my own beliefs and values. For example, as the researcher, my culture, how I observe things, and how I use information can affect the study's results.

These personal biases can change how I collect and interpret the data, showing that my view as a researcher can influence the study's findings.

For this reason, it important to recognise that the researcher’s axiology in the context of this study is biased, and the generated knowledge is bound to values, time and a specific context (Saunders et al., 2016). To address the researcher’s bias, several methodological choices have been employed that ensure transparency, reflexivity, and potential impact of bias on the research outcomes. First, the encounter-episode framework was introduced to account for the factor of time and reduce bias (*see* Section *2.3.4*). This framework provides a structured approach to understanding and analysing the actors and their barriers over time. This helps to mitigate potential biases introduced by the researcher’s perspectives at any given point. Second, seeing the ANT of Latour (1984) combined with the multiple case study methodology of Yin (2018) helps reduce subjective biases and capture the complexity of the actor relationships in the MaaS ecosystem by enabling a more holistic and objective exploration of the social reality. Further, this governs the methodological choice (*see* Section *4.2)* and contributes to the credibility of the study by addressing potential biases that may arise during the research process. Third, Cunliffe (2003) points out that radical reflexivity is needed to reflect on and question the researcher’s values to reduce bias. The challenge will be to enter and understand the social world of MaaS from the participants’ point of view. This bias will be addressed throughout the study by critical reflection and applying ANT. Here, the researcher continuously reflects on personal biases and values, questioning assumptions and perspectives throughout the research journey (*see* Subsection 4.4.5 and Section 7.5).

Theoretical Perspective

Understanding the evolving MaaS business ecosystem's social and technical world requires a theoretical perspective that allows different meanings and realities to be revealed. According to Yin (2018), a constructivist approach can capture the perspectives of different participants and thus can uncover the barriers they face in their MaaS business ecosystem.

Saunders et al. (2016) emphasise that a constructivist approach allows one to understand a concept in-depth. As a result, being a constructivist helps to explore the different opinions from varying cases. While this perspective accounts for the social understanding within the MaaS business ecosystem, a theoretical perspective on technological understanding is needed. Brey (1997) suggests that technology needs to be understood by investigating social and technological controversies, disagreements, and difficulties in which the actors are involved. In this context, Brey (1997) argues that social constructivist approaches can help and classifies such approaches into three groups: strong social constructivism, mild social constructivism, and actor network theory. Strong social constructivism is aligned with the sociology of scientific knowledge and explains technological change only through social practices derived from the interpretations of the actors involved. Entities can be divided between social, natural and technical entities, but no effects are attributed to technology (Tatnall, 2005). Compared to that, mild social constructivism approaches are socially shaping. Socially shaping means that social, natural, and technical differences are acknowledged and examined using social factors. Concretely, social shaping allows attributing effects for non-social factors embedded into social context (Brey, 1997).

Researching barriers in the MaaS business ecosystem will need to treat both the social and the technical perspectives equally. ANT is known as the sociology of translation and can be adopted as a tool to explore collective socio-technical processes while analysing the human and non-human actors who play a role in a complex network called assemblage (Seuwou et al., 2016). All actors are treated equally important and form an actor network through translation (Latour, 2007).

For this reason, the thesis has adopted ANT as the underlying theory to conceptualise actors and their relationships and seek to understand their barriers in the complex MaaS business ecosystem.

4.2 Research Design

According to Crotty (1998), the research philosophy informs the methodology and is considered the framework for the research. The methodology is a philosophical framework within which a set of methods can be systematically applied (Guba & Lincoln, 1994). This thesis relies on the MaaS business ecosystem actor network and the barriers identified through the SLR. For researching the barriers of the MaaS business ecosystem in its real-world context, the Design Science Research (DSR) of Hevner (2007), in combination with the case study research of Yin (2018), has been adopted as the research methodology. This section first justifies the chosen research design and strategy and then introduces the empirical research design.

Justification of the Chosen Research Design and Strategy

This thesis adopts DSR because it enables the researcher to select and apply the appropriate methods for constructing and evaluating an artefact (Hevner, 2007). For developing the MaaS business ecosystem artefact, DSR offers an iterative step-by-step process in which artefacts and theory can be generated and verified, both inductively and deductively (Sonnenberg & vom Brocke, 2012). Researching MaaS and its business ecosystem requires a deep understanding of the barriers in their practical context. This requires rigorous and consistent methods which are underpinned by theory. Experimental research and survey strategies highly control the context variables and are limited by the number of variables for which the data is collected (Saunders et al., 2016). In contrast, case study research puts emphasis on understanding the real-world context and is, in its core features, directly involved with actors, systems or processes in the field (Jönsson & Lukka, 2006). A case study research design investigates a contemporary phenomenon in depth and within its real context and therefore helps to explore it while locating it in a conceptual framework (Saunders et al., 2016). Further, the more the research questions require an extensive and "in-depth" description of some social phenomenon, the more suited case study research is (Yin, 2018). Thus, it studies the case and its context in-depth within its real-life setting (Dubois & Gadde, 2002). This approach fits this research as the goal is to understand the barriers in the MaaS business ecosystem. Even inductive reasoning with theory building could be feasible but is only partly emphasised in this thesis (Eisenhardt, 1989). This thesis's qualitative case study research is mainly deductive but allows new inductive codes to emerge during the interviews.

Presenting the Research Design

Figure 13 shows the research design adopting DSR and multiple case study research. In the following, this research design is introduced in detail.

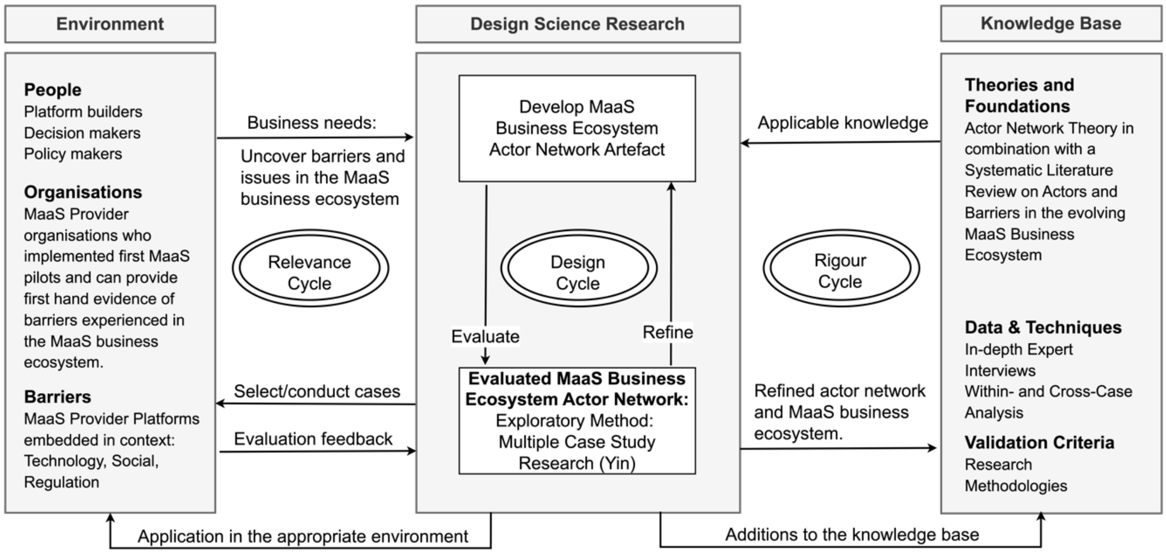


Figure 13. Research Design of this Thesis adapted from Hevner (2007) and Yin (2018) published by Gebhart et al. (2023)

DSR improves the environment by introducing new and innovative artefacts and the processes of building these artefacts (Hevner, 2007). In addition, DSR enables the researcher to select and apply appropriate methods for constructing and evaluating the artefact (Hevner, 2007). Further, it offers an iterative step-by-step process in which artefacts and theory can be generated and verified, deductively and inductively (Sonnenberg & vom Brocke, 2012). To ensure a high-quality research design, Hevner (2007) introduces three research cycles - the relevance, design, and rigour cycle. The following paragraphs describe how these cycles are used for this thesis.

The Relevance Cycle

Figure 13 highlights the relevance cycle between the environment on the left and DSR in the middle. According to Hevner (2007), the relevance cycle ensures that the environment (context) is improved by introducing new and innovative artefacts. This environmental domain compromises people, organisations, and the barriers they face. The main goal of the relevance cycle is that opportunities and problems are identified and represented through requirements that need to be addressed with empiric work (Drechsler & Hevner, 2016). In the case of this research, the environment has been defined through conducting an SLR in the previous chapters. This environment consists of people like platform builders, decision, and policymakers in the MaaS business ecosystem. Those people are directly connected to organisations (actors) which are also part of the MaaS business ecosystem. The organisations researched are MaaS provider organisations that implemented initial MaaS pilots and can provide first-hand evidence of barriers in the MaaS business ecosystem. These barriers have been uncovered from the literature and are faced by the MaaS providers and actors.

Thus, the cases are defined by the people and organisation and bounded by the characteristics of barriers in the MaaS business ecosystem. As a result, the relevance cycle initiates the DSR by spanning the context and providing the requirements and problems to be addressed (Hevner, 2007). In conclusion, the MaaS business ecosystem artefact will be evaluated through feedback from the environment through multiple case study research and amended before it is returned for its application in the appropriate environment.

The Design Cycle

The design cycle is the centre of DSR and connects the environment with the knowledge base (Hevner, 2007). For that, DSR takes the requirements (need to uncover barriers in the MaaS business ecosystem) from the relevance cycle and applies theories and methods (ANT, SLR and case study research) from the rigour cycle. The design cycle executes the research by iterating between constructing, evaluating, and refining the artefact. In this thesis, the iterations can be seen as the cases selected from the environment to uncover and research the MaaS business ecosystem.

For this, the multiple case study research methodology of Yin (2018) is adopted. This methodology will be described in detail in the next section and helps to research the associations between the actors in combination with in-depth interviews to gain insights into the phenomenon of the MaaS business ecosystem and analyse what hinders MaaS providers in building up their ecosystem. An essential part of this approach is developing a conceptual representation known as a MaaS business ecosystem artefact. In this context, this "artefact" refers to the conceptual understanding of ANT that captures the relationships of the MaaS provider with other human and non-human (for example IT-Systems) actors within the MaaS ecosystem. This artefact will be an outcome of the design cycle, undergoing evaluation to contribute to both the rigour (additions to the knowledge base) and relevance cycle (application in the appropriate environment). These results are discussed in Chapter 6 of this thesis as theoretical and practical implications.

The Rigour Cycle

The rigour cycle in Figure 13 connects DSR with the knowledge base. This cycle ensures that DSR is grounded in the theoretical domain and that the past knowledge of data collection methodology is applied to the research project (Hevner, 2007). This knowledge base consists of theories and foundations, data & techniques, and validation criteria. The theories and foundations ensure that the applicable knowledge is used to develop the MaaS business ecosystem actor network artefact. This thesis used ANT as the theoretical foundation for conceptualisation and an SLR to research and review actors in the MaaS business ecosystem. The foundations for rigorous DSR have been set through this use of theory and methods. For further construction of the DSR artefact in the design cycle, the data & techniques, and validation criteria must be selected and applied.

For these, in-depth expert interviews are conducted, and the cases are analysed using within and cross-case analysis. Further details will be described in the following sections. The results of the design cycle will be added to the knowledge base and extend the existing theories (Hevner, 2007).

4.3 Research Strategy

To operationalise the presented research design in a strategy, the DSR process steps are adopted. DSR includes five process steps: awareness of the problem, suggestion, development, evaluation, and conclusion (Hevner & Chatterjee, 2010). For each phase, operative RQs and expected outcomes are detailed in Table 10.

Table 10. DSR Research Strategy for this Thesis

DSR Phase	*Main Research Questions*	*Operative Research Questions*	*Expected Outcomes*	*Artefact Contribution*
Awareness (Chapter 2)	**RQ 1**: What are the key elements and actors of the MaaS business ecosystem?	**RQ 1.1**: Which core characteristics of MaaS exist in the academic literature?	A conceptual understanding of the MaaS business ecosystem (Section 2.2.3).	Understanding the environment (context) of the artefact and identifying MaaS characteristics and actors.
		RQ 1.2: Which actors exist in the MaaS business ecosystem?	A thematic map of identified actors. (Section 2.2.4 and Section 3.7.1).	
Suggestion and Development (Chapters 2 and 3)	**RQ 2**: How can the MaaS business ecosystem be assembled and translated (problematised, interested, enrolled, and mobilised) with ANT?	**RQ 2.1**: How can ANT support assembling and translating actors in the MaaS business ecosystem?	An actor network of the MaaS business ecosystem by a novel combination of MaaS with ANT (Section 2.3.4).	Planning and developing the MaaS business ecosystem actor network through applying ANT and identifying barrier themes.
		RQ 2.2: Which relationships exist between the different actors in the MaaS business ecosystem?	An actor network analysis to group actors revealing relationships logically (Section 3.7.2 and Section 3.7.3).	
		RQ 2.3: Which barriers are being faced in the MaaS business ecosystem?	A thematic examination of barriers which currently exist for the actors in the actor network (Section 3.7.4).	
Evaluation and Conclusion (Chapters 5, 6, 7 and Appendix)	**RQ 3**: How can the MaaS actor network be used to evaluate case-specific barriers in MaaS business ecosystems?	**RQ 3.1:** How can the actor network and the identified barriers be applied to practice?	Case-specific inspections of the relationships and translations happening inside MaaS business ecosystems (Section 5.1).	Applying the MaaS business ecosystem actor network artefact in its environment, evaluating it with multiple case study research and generating new actionable insights to overcome the barriers.
		RQ 3.2: How can the findings of the experts be located back to the findings of the literature?	An evaluated MaaS business ecosystem actor network artefact through case-specific feedback with expert interviews (Section 5.3 and Chapter 6).	
		RQ 3.3: How can the evaluation of the barriers with the actor network be used to derive learnings on overcoming the barriers?	Synthesised success factors, and prospects to overcome barriers in MaaS business ecosystems (Section 6.5 and Appendix J).	

The following paragraphs describe the research strategy, including the different DSR research phases. Here, the research phases are iterated horizontally over the different phases of DSR, while ANT is vertically integrated after the awareness phase. The process steps have been mapped in Figure 14 to this research's environment (context). This enables the translation of the actors in the MaaS business ecosystem with ANT while running through the process steps of DSR. It is essential to understand that the MaaS business ecosystem artefact serves as the basis to inspect and evaluate the barriers of the actors.

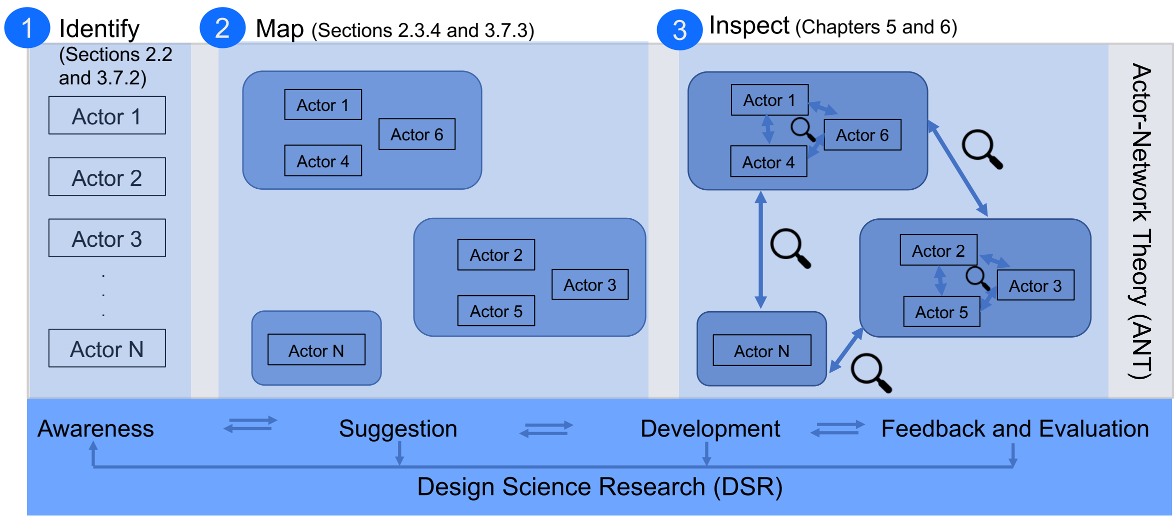


Figure 14. Three-Step Research Strategy of this Thesis

Awareness Phase: Understanding the MaaS Problem Environment

The first phase of this research can be considered the awareness phase. In this initial research phase of DSR, a deep understanding of the problem and its environment is developed (Hevner & Chatterjee, 2010). The initial research problem has been defined in Section 1.2 and expanded with gaps for the empirical part in Section 3.8. This thesis went through the awareness phase in Chapters 1 and 2, in which RQ 1 consisting of the operational RQ 1.1 and RQ 1.2 have been answered. Here, different actors of the MaaS business ecosystem were identified, listed, and described.

The first outcome was a conceptual understanding of the MaaS business ecosystem (Section 2.2.3). The second outcome was a thematic map of identified actors, which exposed research gaps for conceptualising the MaaS business ecosystem and underlying theory (Section 2.2.4 and Section 3.7.1). Those two outcomes contributed to understanding the artefact's environment (context) and helped systematically explore the actors and their key characteristics within the MaaS business ecosystem. On top of this, the conceptual requirements of MaaS and its business ecosystem were identified.

Suggestion Phase: Proposing the MaaS Business Ecosystem Actor Network Artefact with Barrier Themes

After identifying the problem, the next step is to suggest a solution based on the problem. For making this proposal, Hevner and Chatterjee (2010) suggest using existing theory. This thesis addresses the suggestion phase by answering RQ 2.1 to 2.3. In this thesis, the theoretical perspective of ANT has been applied to map the results of the previous phase in an actor network of the MaaS business ecosystem (Section 2.3.4). This actor network of the MaaS business ecosystem reveals the actors and their relationships and therefore identifies barriers existing in the MaaS business ecosystem (Section 3.7.3).

As a result, emerged themes, patterns, and relationships are organised and serve as a conceptual framework to evaluate the barriers from the MaaS business ecosystem actor network in the field (Section 3.7.4). Thus, this phase suggests the MaaS business ecosystem actor network, including barrier themes that need to be empirically evaluated in the next phase.

Development Phase: Developing the MaaS Business Ecosystem Artefact

The outputs of the previous two phases serve to develop the artefact. The development phase is the core of the DSR between the rigour and relevance cycle and adopts the multiple case study research procedure of Yin (2018), depicted in Figure 15. Here it is sought to develop the artefact from theory and gain expert feedback concerning the barriers.

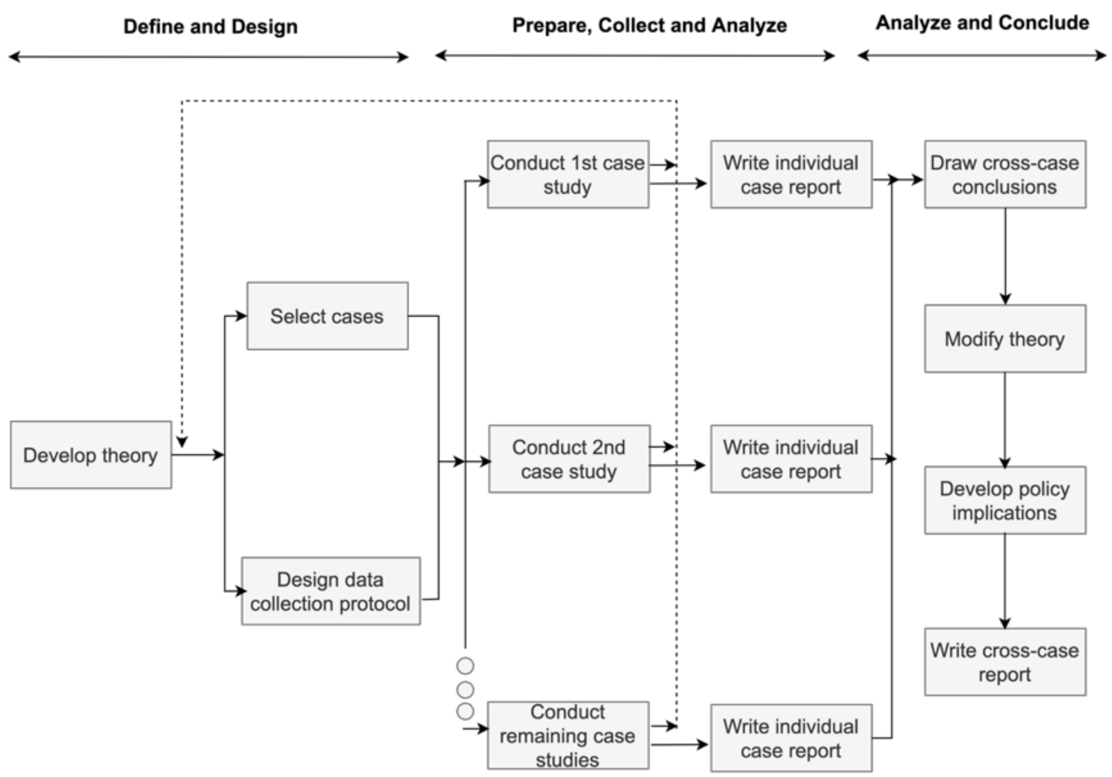


Figure 15. Multiple Case Study Research Procedure of Yin (2018)

According to Yin (2018), a research strategy follows a clear path to get from here to there, including five components: case study questions, propositions, its cases, logic linking the data to propositions and the criteria for interpreting the findings. In this thesis's development phase, the plan is to prove that the barriers identified from the SLR resonate in the field and help obtain success factors for platforms and decision-makers in the MaaS business ecosystem. Multiple case studies will be conducted to collect the qualitative data, described in detail in Section 4.4 of this thesis.

The case study questions are retrieved from the barrier themes and their characteristics from the SLR. With the help of in-depth one-to-one expert interviews from chosen individuals in the case company, the artefact will be adapted for each case and used to discuss the barriers experienced. These interviews focus on obtaining knowledge and insights into case-specific barriers in the MaaS business ecosystem, enabling it to enrich the artefact and extend its findings. Finally, these findings will be compared across the cases with criteria for interpreting them, described in the case study report in Section 4.4.4. The goal of the development phase is that the artefact proves its relevancy in the application environment.

Evaluation Phase: Evaluating the MaaS Actor Network and Barriers

Sonnenberg and vom Brocke (2012) emphasise that evaluation happens after each DSR phase, which can be either before (ex-ante) or after (ex-post) the construction of the artefact. In the proposed research, these evaluation activities will be adopted and happen throughout the process of creating the artefact.

Ex ante evaluation in this research will happen through two evaluation activities. The first evaluation activity happens after the problem has been identified through logical reasoning in combination with a rigorous literature review. Through these activities, this thesis demonstrated in the previous chapters that the envisioned design problem is novel, relevant for practice and represents a research gap in the given environment (Sonnenberg & vom Brocke, 2012). The second evaluation activity proves that a particular artefact design establishes the solution to the stated problem (Sonnenberg & vom Brocke, 2012). This thesis follows the assertion pattern, stating why the design is superior and will work in the given situation. In particular, the previous chapters highlighted that the ANT could be used to translate the actors and identify barriers in the MaaS business ecosystem.

A crucial part of this evaluation activity is demonstrating how the artefact is expected to work (Sonnenberg & vom Brocke, 2012). This has been shown in the previous chapter by identifying barrier themes and will be demonstrated in the following chapter with empirical evaluation using case study research.

Ex-post evaluation includes two more activities (activities three and four). Evaluation activity three links ex-ante and ex-post evaluations and serves as an initial demonstration or prototype showing that it works in its given environment (Sonnenberg & vom Brocke, 2012). In this thesis evaluation, activity three is conducted by performing a pilot case study with expert interviews (*see* Appendix E). Details of the case study protocol are introduced in Section 4.4.

Evaluation activity four is the last activity showing that the artefact is applicable and valuable in practice (Sonnenberg & vom Brocke, 2012). For this final evaluation activity, multiple case study research in combination with one-to-one in-depth expert interviews is used. These interviews aim to evaluate the artefact's socio-technical usefulness in its academic and business context (Hevner & Chatterjee, 2010). This socio-technical evaluation will be done by researching identified barriers in their practical context (Sections 5.1 and 5.3). The evaluation results and insights will complement the MaaS business ecosystem artefact. Case-specific feedback through expert interviews will evaluate whether the artefact is applicable and useful in practice. Details of the data collection are introduced in Section 4.4.2. All evaluation activities are highly iterative, meaning that several feedback cycles are included and that the findings of initial interviews help to reshape the problem for further interviews. The goal of the evaluation activities adopted by this thesis is to improve the rigour and impact of the research artefact by evaluating barrier themes of the MaaS business ecosystem actor network.

Conclusion Phase: Reporting the Results and Managerial Implications

The conclusion phase is the last phase that reports the results and maps them back to the literature. Cross-case conclusions will be drawn by writing a cross-case study report (Chapters 6 and 7). Expected findings include actionable insights for practitioners and theory to overcome barriers in the MaaS business ecosystem. The expected managerial implications include success factors and prospects for decision-makers developing policy implications for the MaaS business ecosystem, which can amend existing ANT theory, providing in-depth and unique insights for academics and practitioners (Section 6.5 and Appendix J).

4.4 Case Study Protocol

This section introduces the case study protocol adopted as part of the research strategy. According to Yin (2018), the case study protocol is needed to explicitly describe the data collection and analysis strategy, which is part of an empirical case study. While a case study protocol is recommended for single case studies, it is essential for doing multiple-case study research as it contains all procedures and general rules that must be followed (Yin, 2018). This research combines the case study protocol of Yin (2018) and the protocol of Brereton et al. (2008). Yin (2018) distinguishes between four sections. First is the case study overview, which includes background information on the case, the issues, the target audience, and the criteria for selecting the cases, including theoretical propositions. This is represented through Section 4.4.1 in this thesis. Second, the data collection procedures need to be explicitly described, including the field procedures, data collection and sampling strategy (*see* Section 4.4.2). Third, the expert interview design and protocol questions address the five levels of questions from Yin (2018) accompanied by expected outcomes (*see* Section 4.4.3).

Fourth, the last part of the case study protocol is the tentative outline for the case study report. The case study report (*see* Section 4.4.4) includes the data analysis strategy and criteria for interpreting the case study findings (Brereton et al., 2008). Finally, the quality criteria and considerations for protecting human subjects through ethical standards are described (*see* Section 4.4.5).

4.4.1 Selection and Bounding of the Case Studies

This subsection introduces the rationale behind the selection criteria and bounding of the case studies. In terms of terminology, the cases of this thesis are reflected through companies (unit of analysis) and experts from the companies are considered the participants with relevant roles in the case company. According to Yin (2018), this describes a holistic case study approach, as the unit of analysis is the whole case. The research is concerned with finding and validating barriers in the MaaS business ecosystem. In this context, the evidence and findings are reported by individual experts for the respective case. As this thesis follows an interpretive approach, the scope and selection need to be described in detail to allow the readers to make their own links to existing theory (Stake, 2008).

This thesis adopts the two-phased selection approach of Yin (2018). First, the criteria for case selection and then the requirements for the interview candidates within the cases are stated. For the case selection, this thesis follows a non-probability purposive-homogenous sampling strategy (Saunders et al., 2016). Purposive sampling has been applied, as the researcher defines in the following sampling research criteria, which are based on the environment and applicability in the MaaS business ecosystem (Miles & Huberman, 1994).

Three selection criteria scope the cases, (1) being a MaaS provider, that (2) employs Public-Private Partnerships (PPP) or Public-Private-People Partnerships (PPPP) MaaS operator models which are restricted to (3) urban and geographic restrictions.

Case Selection Criterion 1 **[MaaS Provider]:** The selected case company must be a MaaS provider, meaning that the case needs to be at the centre of the MaaS business ecosystem to experience the barriers in the MaaS business ecosystem entirely. A possibility would be to collect data from diverse and heterogenous participants (companies) in the MaaS business ecosystem.

However, this would lead to heterogenous views and perspectives on the barriers and would be hard to compare. For this reason, the selection criteria are that the case company is an emerging MaaS provider in the business ecosystem. Thus, the homogeneity of the cases is improved, and the findings can be better compared across the interview participants (Zott & Huy, 2007).

Case Selection Criterion 2 **[PPP / PPPP MaaS Operator Models]:** The selected case company needs to employ Public Private People Partnership (PPP / PPPP) MaaS operator models. In those operator models, the municipality or city is the MaaS provider and integrates the different types of actors and services (Eckhardt et al., 2017).

In addition, those models include people as prosumers and are based on the SLR closest to the general MaaS idea (Eckhardt, 2020; Polydoropoulou, Pagoni, Tsirimpa, et al., 2020). Further, the most promising MaaS platforms are currently arising within this space.

Case Selection Criterion 3 **[Urban and Geographic Restrictions]:** While rural areas with less population density will also be important for MaaS in future, MaaS is expected to have the most impact in urban areas. For this reason, the first key MaaS implementations are currently happening in major cities and urban areas. Therefore, only developed urban geographic living areas, such as major urban centres, will be selected for this thesis. In this context, "urban centres" means locations with significant population density and infrastructure development. Multi-city urban implementations can also represent such MaaS centres because the urban landscape varies globally. To limit the scope, the included cases will be restricted to European MaaS implementations, which have been developed within the past three years. This selection criterion ensures that the findings from the literature are validated and policy recommendations for MaaS providers and actors in Europe can be given.

Choosing the Case Studies including their Boundaries and Limitations

The above criteria for case selection ensure that cases are selected in such a way that similar results can be anticipated. Yin (2018) describes this selection strategy as literal replication. This ensures rigour and is also vital for qualitative validity. Through selecting the cases, the goal is to find out if the predictions are contrary or do support the theoretical propositions of the SLR. For that, the researcher needs to develop a detailed and nuanced description of the case studies (Ridder et al., 2012). According to Flyvbjerg (2011), determining boundaries is critical to defining the cases. Thus, following the case selection criteria, Figure 16 displays a visual map with all MaaS projects happening in Europe which combine public transport and shared mobility, which is being maintained by Stead (2023) and shared online in the "MaaSterminds" community.

Figure 16. MaaS Projects Combining Public and Shared Mobility by Stead (2023)

This map and a systematic web search have been used as a basis to identify relevant cases. In this search, MaaS projects were chosen based on the selection criteria mentioned in the previous section. This process excluded, for example, pure journey planning and mobile ticketing solutions, which were not considered MaaS solutions. Following the case selection criteria 1-3 combined with this search revealed nine potential cases that could be researched. Regarding analysing the cases, the within-case reports outline these different cases (*see* Table 12 in Section 5.1). Details of the participants of these cases are described in Table 11, which also describes the case's origin.

4.4.2 Interview Data Collection, Population, and Sampling Procedures

This subsection introduces the data collection, population, and sampling procedures for the case interviews. For this, primary data is collected from experts of the selected case companies. Both the artefact construction and evaluation are dependent on the data collected. Because of this, an explicit interview data collection procedure is needed.

Figure 17 depicts the interview data collection protocol of Bokolo et al. (2020), which was employed to avoid bias and incorrect interpretation in the data collection procedures. The research philosophy of this thesis is interpretive. Thus, the qualitative data collection aims to verify the actor network and barriers of the MaaS business ecosystem linked to the MaaS cases. The thematisation and interview design, including the questions, are formulated as deductive as possible, derived from the conceptual framework (actor network of the MaaS business ecosystem). This formulation ensures a strong link between the research questions, the aim, and the objectives. Both steps are defined in the following Subsection, 4.4.3.

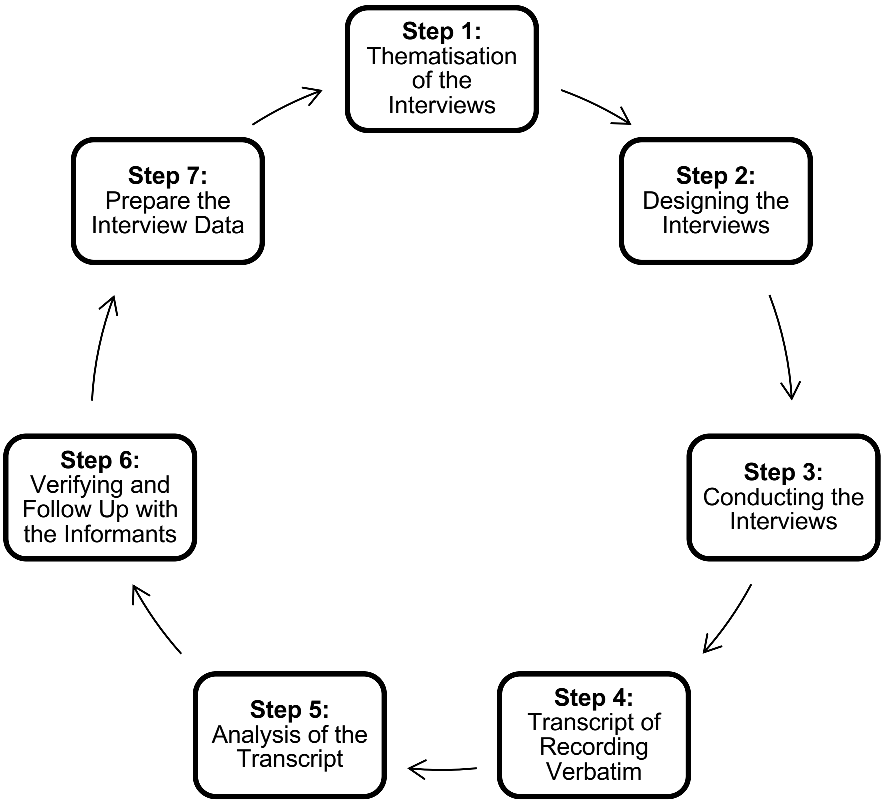


Figure 17. Interview Data Collection Procedure adopted from Bokolo et al. (2020)

The next step includes conducting the interviews. The expert interviews, lasting one hour each and centred on the case study topics, will provide evidence following the interview protocol (Yin, 2018). This interview protocol is based on the emerged characteristics of the SLR.

It consists of unstructured or semi-structured interview questions conducted in one-to-one in-depth expert interviews (Vasileiou et al., 2018). More details of this protocol are introduced in the following subsection. According to Brereton et al. (2008), the questions during the interview need to be asked in an unbiased manner. Potential bias could arise due to poorly articulated bias. Thus, the researcher needs reflexivity Yin (2018). This reflexivity is being addressed using ANT theory behind the questions and the SLR, which brought up the barriers that need to be validated in the cases. The interviews are conducted using Cisco Webex or Microsoft Teams. During the interview process and before the meeting, the participants were asked for permission to record the interview. More detailed ethical considerations are described in more depth in Subsection 4.4.5.

Further, contextual data have been recorded during the interview, including but not limited to the location, date and time, the setting, more detailed background information (role, title, gender) and the first impression of the interview (Saunders et al., 2016). The interview sessions were held in the local language (English or German) whenever possible. After the interviews, the next step includes creating a verbatim transcript of the recording. For this, automatic transcription software has been used. The preliminary transcript has then been used to manually transcribe the interview by matching the audio recording with handwritten notes following the transcription guidelines of Kuckartz (2016). Transcript summaries were kept per transcription, covering the interview's main points. However, not only is the transcription stored, but also more contextual data have been kept in a reflective journal, including the tone, non-verbal communication, and thoughts. This data is stored separately, anonymously, and confidential and will only be connected following the ethical guidelines if needed.

Further, self-memos are created to keep the impressions and ideas fresh. After the transcription, a copy of the transcript and the informed consent form were sent back to the participant for final checking. After the transcription, the transcript was analysed following the data analysis strategy (*see* Subsection 4.4.4).

Case Expert Population and Sampling Procedures

In the first selection step, the cases have been selected. Now in this selection step, the criteria for the experts are introduced. The cases have been selected to be homogenous in the criteria but heterogenous in their context. For the experts, this purposive-homogenous sampling strategy is continued with the following criteria:

Expert Selection Criterion 1 **[Part of the Selected Cases]:** The expert participants need to work or have previously worked directly with the case companies. That means the experts are either working as part of the public transportation provider or in the private company that implements the MaaS solution. The first iteration of expert feedback excludes experts in the wider business ecosystem. This exclusion is on purpose, as this research mainly focuses on barriers experienced in the heart of the ecosystem – the MaaS provider.

Expert Selection Criterion 2 **[Managerial Experience]:** The second criterion selects only experts with managerial experience in the respective case companies. This selection includes executives, managing consultants or employees with managerial tasks to ensure they have a more strategic and holistic view of the MaaS actor network, including the barriers. Experts in the operative business, like an engineer, would only have a limited technical point of view of the component that is being implemented and not on the strategic barriers faced in the MaaS business ecosystem. This study is interested in a holistic picture of barriers that the case company faces.

Further, executives and managers are more likely to agree to an interview, especially when the topic is exciting and relevant to their current work (Saunders et al., 2016). Thus, this research made it relevant and exciting for them to join. For example, they were offered the findings of this study by emphasising that they can learn from MaaS platforms in other major European cities to develop strategies to cope with barriers.

Expert Selection Criterion 3 **[Topic Experience]:** The third expert selection criterion is topic experience. The managers should be selected according to their experience, including management of technical topics, partnerships with other companies, the ecosystem, business development and holistic views of the case company. The experts need to have experience working with MaaS solutions and the ecosystem to experience the barriers faced by the companies in the MaaS business ecosystem.

Criteria-Based Expert Selection

For finding initial experts matching those criteria, news articles, the internet and professional social networks like LinkedIn were explored. If potential candidates were identified, they were directly contacted through LinkedIn or email. After identifying the experts, they were asked if they wanted to be interviewed on this research topic. Then, the first conversation was initiated with a letter of introduction following the ethical considerations (*see* Subsection 4.4.5). This digital introduction letter contains the most important information about the researched content and is sent by email if the feedback is positive.

After that, the individual virtual one-to-one in-depth interviews were scheduled with the questions of Subsection 4.4.3. After the interview, the snowballing sampling technique of Goodman (1961) was applied. Therefore, the interviewees were asked if they knew somebody in their network who matched the selection criteria.

Following this approach, 20 experts have been selected. Table 11 displays those experts, their roles, the case origin, the interview language, and the duration.

Table 11. Selected Case Experts for the Interviews

ID	Role	Case Origin	Interview Language	Duration
PI1	MaaS SME Expert	France	English	48 min
PI2	Senior Researcher	Germany	English	63 min
I1	Managing Director	Germany	German	61 min
I2	Partner Project Leader	Switzerland	German	79 min
I3	MaaS Project Lead	Switzerland	German	48 min
I4	MaaS Policy Coordinator	Finland	English	59 min
I5	MaaS Co-Founder	Scotland	English	60 min
I6	MaaS Project Advisor	Lithuania	English	60 min
I7	MaaS Consultant	Germany	German	40 min
I8	MaaS Chief Revenue Officer	England	English	70 min
I9	Product Owner MaaS	Germany	German	56 min
I10	MaaS Project Lead	England	English	59 min
I11	Head of Digital Channels	Hungary	English	63 min
I12	Mobility Director	Spain	English	56 min
I13	Business Development Manager	Netherlands	English	66 min
I14	MaaS Product Owner	Czech Republic	English	67 min
I15	Head of Product Management	Wales	English	65 min
I16	Senior Innovation Officer	England	English	44 min
I17	MaaS Project Officer	Scotland	English	42 min
I18	MaaS Lead Consultant	England	English	49 min

4.4.3 Expert Interview Design and Protocol Questions

This subsection introduces the expert interview design and protocol questions following the case study protocol strategy of Yin (2018). The expert interviews, which constitute the line of inquiry and help to gather valid and reliable data, provide a purposeful conversation that helps to answer this thesis's research questions and objectives (Saunders et al., 2016). To achieve this, the themes of the interviews are derived from the characteristics of the SLR. Further, a chain of evidence is maintained from the case study questions to the expected outcomes, links to theory, citations to specific sources and the case study database and findings (Yin, 2018). This chain is initialised by describing the interview design and structure in the following paragraphs. The detailed protocol can be found in Appendix E. In the Appendix, Table 59 maps the research questions to the interview protocol questions and concepts identified from the SLR with their expected outcomes.

Interview Design and Structure

The topology of interviews contains structured, semi-structured and unstructured in-depth interviews, which can be either standardised or non-standardised (Saunders et al., 2016). The interviews of this thesis were conducted as one-to-one virtual meetings organised in Webex or Teams and included different types of interviews. In-depth and semi-structured interviews allow for capturing answers to a large number of questions which are complex and sometimes open-ended (Saunders et al., 2016). These types of questions allow the researcher to explore the contextual boundaries of the experiences of the interviewees and can uncover hidden views and reflections (Gubrium et al., 2012). The questions follow the interview design and question design, and the interview protocol is split into three parts:

The first part starts with open questions about the interviewees, their profession and what role they think their case company is taking in the MaaS business ecosystem.

Starting with open questions at the beginning ensures that the respondent is not getting too biased when later the closed and semi-open questions are introduced, which validate the findings of the actor network and conceptual model of the MaaS business ecosystem. Through this interview design, without assumptions and too much-provided information about the topic, the respondents can speak and think freely about the barriers they face in the MaaS business ecosystem (Creswell & Plano Clark, 2017).

Second, after this introductory phase, semi-structured open questions are asked, which allow the allocation of the interview case company within the MaaS business ecosystem actor network. In this context, the MaaS business ecosystem actor network artefact is presented, and questions for evaluation are asked. These questions of the first part help to match the findings to the conceptual framework and the barriers found in the literature. Further, this verifies the selection criteria and enables a cross-case analysis that can be conducted based on the findings, making sure that the case companies are taking similar actor roles in the MaaS business ecosystem. Now, after the case company has been allocated to the business ecosystem, questions can be asked regarding the completeness of the actor network artefact. Any identified misalignments to the findings from the literature will trigger more detailed probes for clarification.

Further, questions regarding the relationships or translations in the network are asked for evaluation purposes. Here, the interview questions aim to find out the three most essential actors from the point of view of the case companies. During these questions, the interviewees are asked to explain why they took the decision.

This part of the actor network analysis limits the actor network only to the relevant relationships for the case.

Conclusively, the actor network analysis helps validate the literature review's conceptual findings and exercise a reality check on how gaps from the literature exist in the current field of MaaS implementations in Germany. These findings are then amended into the literature. In addition, the second part of the interview design is concerned with validating the barriers in its environmental context by showing the findings from the SLR to the participants. This validation is achieved through designing semi-structured interviews, which are structured according to the barriers derived from the literature. This list of the identified barriers is presented to the interview, and questions are asked. For each barrier shown, the interviewee is asked whether those barriers are faced in their case company. It is ensured that the interview will be non-directive, which means the participant is allowed to freely talk about the experienced barriers (Saunders et al., 2016). After each barrier has been discussed, the interviewees are asked to think openly if any barriers are missing from their point of view. This process enables a more profound exploration of the underlying translation and relationships inside the MaaS business ecosystem. Further, this procedure helps inductive characteristics to come up which are not covered by the literature. After this step, it can be ensured that all barriers are identified.

The third part of the interview design addresses overcoming these barriers with policy recommendations and other strategies. To achieve this, this part is mainly unstructured and thus inductively explores strategies for coping with the barriers. The MaaS business ecosystem actor network will be shown again. For further probing, the interview design uses the critical incident technique (Saunders et al., 2016).

According to Keaveney (1995), a critical incident defines an event where the consequences are so clear that the participant has an exact idea concerning the effects of this event.

Adopted for this research, the interviewees will be asked about any critical event in which they have experienced those barriers and their strategy to overcome them. For this, the probing questions ask for details concerning the sources of this issue and which actor or potential external party like politics should address it to resolve it. The last questions are open and unstructured and go into the direction of the future setup of the actor network. For this, participants are asked what they expect from other actors in the ecosystem so that the development can thrive and to use their imagination to anticipate the future of the MaaS business ecosystem.

Interview Protocol Questions and Expected Outcomes

Yin (2018) suggests for the explicit data collection five levels of questions when collecting data. Level 1 questions are verbalised to specific interviewees and set the context with open-ended questions. These questions are addressed in the first part with the interview questions A1, A2 and A3. This case context is required to satisfy the needs of the line of inquiry of level 2 questions. Level 2 questions follow the line of inquiry and are answered within a single case study but can be part of a more extensive, multiple-case study. These questions are mainly deductive, derived from the conceptual framework and are represented through interview questions B1, B2 and B3. Level 3 questions are not part of the protocol for collecting data, as they can only be addressed after the data from all single-case studies have been examined. However, the questions are designed in a way that cross-examinations are possible.

The level 4 and level 5 questions are limitations and go beyond the empirical data. These questions form the inductive part of this research, and the questions are mainly represented through interview questions C1, C2 and C3.

The questions are structured with the help of these five levels and the three parts priorly introduced. The interview questions mainly use open-ended “why”, “what”, and “how” questions, which help to address the subjective experiences of the interviewees (Saunders et al., 2016). Each question set starts with a main question, potential probes, the objectives, expected data and analysis. This process follows the scheme of likely sources of evidence (Yin, 2018).

4.4.4 Case Study Report Including Data Analysis and Presentation

This subsection introduces the case study report, including the data analysis and presentation strategy. The gathered data from the three interview parts will be analysed qualitatively, and the strategy combines evaluation and exploration. Analysing qualitative data requires the researcher to make sense of subjective and socially constructed meanings (Saunders et al., 2016). To bring that meaning into context, this thesis employs, wherever possible, a deductive qualitative analysis strategy. This strategy has been chosen as the research questions and objectives have been formulated based on existing theory, and this theoretical framework directs the data analysis. The strategy helps to link the existing body of knowledge with the analytical framework (Yin, 2018).

Thus, the data analysis of this thesis relies on the theoretical proposition and matches patterns to compare if the pattern predicted from the theory is valid and applicable in its real-world context (Trochim, 1989). For achieving this, the deductive explanation building of Yin (2018) is used.

Deductive explanation building starts with the theoretical propositions and undertakes those with a purposive case study to compare the findings with the theory. Then, the theoretically based propositions are amended, and another round of purposive case studies is performed. In the context of this thesis, the first pilot interviews are conducted, followed by the main case studies. For each interview in those cases, the findings are compared in relation to theory and amended where possible. Deductive explanation building is close to the deductive coding strategy of (Bryman & Bell, 2011), which starts with theory, hypothesis, interviews, and confirmation or rejection of this theory. The second analysis strategy used for this thesis is thematic analysis. The thematic analysis enables a systematic and flexible approach to analyse the qualitative data by searching for themes and patterns in the evidence (Braun & Clarke, 2006). With this, thematic analysis enables to analyse the data both deductively and inductively by becoming familiar with the data, coding the data, searching for themes, recognising relationships, and refining themes and testing propositions (Saunders et al., 2016).

In this thesis, the data is read and re-read before analysing, and then the a priori codes from the literature are compared. At the same time, the themes and relationships are related back to the research questions (Bryman, 2008). In this context, within- and cross-case analysis (synthesis) tests the theoretical propositions and explores rival theory explanations (Eisenhardt, 1989). As a result, a theme can be seen as an expected answer or characteristic from the literature that can consist of one or multiple codes (scales). These scales and codes describe the data elements that will be combined to address the research questions. This aggregation of data (deductive codes), combined with inductive codes, allows for considering a wide range of possible outcomes and leaves space for alternative explanations.

For each inductive code, a definition is developed, overlapping codes are merged and refined, and redundant codes are removed. This manual analysis of the expert interviews follows these multi-cycle coding strategies (scale and evaluation) and can be found in Appendix F. In there, Table 60 maps the interview questions from the previous subsection with expected answers and themes, the scales, the expected impact on artefact evaluation and the original concepts and sources from the literature.

Data Presentation and Report

The case study report and the data presentation maintain the chain of evidence. This chain starts from the case study questions, the protocol with expected outcomes and links to theory, to the citations of the evidence and findings (Yin, 2018). These citations derive from the deductive explanation building and the thematic analysis and are combined in a narrative. First, case-specific narratives are developed, while cross-specific narratives are formulated to compare and contrast the findings across the cases. Here, the report's structure follows the structure of Table 60 and replaces the expected answers with actual answers and findings. These narratives follow the concept of vignettes, including short descriptions that illustrate the aspects of each case (Yin, 2018). These reports seek a balance between descriptions, analysis, and interpretation. Here, the data display and analysis approach of Miles et al. (2018) is used. The data is first condensed by summarising and simplifying the data from the narrative. At the same time, it is organised and assembled into data summary diagrams, visuals (like the actor network) or matrices and networks.

4.4.5 Case Study Quality Criteria and Ethical Considerations

This final subsection of the case study protocol addresses the case study quality criteria for collecting and analysing qualitative data. Further, it outlines ethical considerations, including the protection of human subjects.

Flyvbjerg (2011) claims that case studies as a research strategy have been criticised because of misunderstandings about their ability to produce generalisable, reliable, and theoretical contributions to knowledge. To overcome these concerns, Yin (2018) defines quality criteria with strategies to cope with them. These quality criteria are now introduced, and the corresponding tactics employed throughout different phases of this study are presented.

Construct Validity – The first quality criterion is construct validity. Creswell and Plano Clark (2017) emphasise that qualitative research must be valid and reliable. Construct validity in that context means the data must identify the correct measure for the studied concept (Yin, 2018). In the proposed study, this is assured by triangulating evidence from multiple sources and verifying the construct through a pilot study in which chosen key experts reviewed the draft case study protocol and conceptual framework of this thesis. The conceptual framework was introduced in Chapter 3, and Chapter 4 introduced the data collection procedures.

Internal Validity – The second quality criterion is internal validity. Internal validity seeks to establish relationships in the data. The proposed study addresses internal validity by comparing the data interpretation with the codes derived from the systematic literature review (Guba & Lincoln, 1994). That enables deductive explanation building, conducting thematic analysis and contrasting the findings to rival explanations. Through these tactics, the proposed study has a high internal validity level, as described in the case study report and analysis and presentation.

External Validity (Generalisability) – The third quality criterion is external validity. In contrast to internal validity, external validity aims to ensure that the findings are accurate and consistent to be generalised and compared with similar research. This research leverages a conceptual framework based on ANT and the SLR (*see* Chapter 3). Further, it employs a literal replication strategy by gathering data from multiple case studies. With this, this research investigates outcomes in a different context, representing Europe. In addition, the process of DSR enables triangulation by allowing cross-checking findings and revisiting earlier steps (*see* Section 4.3). Here, the findings between the cases are analysed with cross-case analysis to demonstrate the broader applicability of the evidence. Going to different stages of DSR ensures the correct usage of methods and instruments and, thus, the generalisability of the study. Finally, transferability is realised by providing a complete description of the research methodology and the theoretical propositions so a similar research project can repeat the research process in other settings (Trochim, 1989).

Reliability – The fourth quality criterion is reliability. The lack of standardisation in semi-structured and in-depth interviews can lead to concerns (Saunders et al., 2016). Reliability demonstrates that the data collection procedures can be repeated with similar results (Yin, 2018). This research ensures this through the case study protocol, which includes the case study database and the chain of evidence (Section 4.4). Reliability comes with dependability and is addressed by acknowledging the that the researcher has different forms of bias (Saunders et al., 2016):

The first form of bias addressed is interviewer bias, which may arise from framing the questions based on the researcher's belief. Here, the credibility of the researcher is an essential factor. To counter this bias, this study recognises the role of the researcher.

For that, the researcher developed a reflective diary and maintained a chain of evidence throughout the study. Further, the questions and information provided were supplied to the interviewees before the interview, fostering transparency and mitigating potential sources of interviewer bias.

The second bias addressed response bias, which describes that the interviewee is willing to participate but may withhold or not thoroughly discuss aspects crucial to the study's topics that need to be explored. Here, it must be emphasised that the interview's outcome is only a partial picture of the situation. To reduce this bias, the researcher adopts a multiple-case study approach, providing a more comprehensive understanding by triangulating information from different cases and ensuring that the outcomes reflect a more holistic perspective of the situation.

The last bias addressed is participation bias, associated with the time required for an interview. This bias is being addressed by prioritising conciseness in the interview process and recognising the potential impact of extended interview durations on participant engagement and response accuracy.

By acknowledging and addressing these biases within the research design and acknowledging the researcher's bias, this study aims to enhance the overall reliability of its findings, leading to a comprehensive exploration of the barriers in the MaaS business ecosystem.

Ethical Considerations of this Study

As this research involves human subjects, special ethical considerations have to be formulated (Yin, 2018). The proposed study will ensure that the *University of Gloucestershire Handbook of Research Ethics* guidelines are adhered. First, all participants were volunteers and informed of their right not to answer a particular question or to withdraw from the interview process at any time.

This informed consent is addressed by the letter of introduction and the informed consent form and must be agreed upon by each subject.

Second, the subjects will be protected from harm, including deception (Yin, 2018). The subjects who are actors in the MaaS business ecosystem are asked to indicate current tensions in relationships. Potentially, there could be the possibility of harmful and intimate information that could be exposed as part of this study. This issue is being addressed by showing the data collection plan to the human subjects in the case studies, anonymising wherever possible and letting the subjects decide before the findings are published.

Third, concerning power relationships, potential issues will be addressed by introducing the researcher as an independent researcher, not a consultant (Bryman, 2008). An outline of the interview questions will also be sent out in advance. The researcher is interested in the development and is sponsored by an independent IT company that wants to gain insights into the MaaS business ecosystem problems to help.

Fourth, the privacy and confidentiality of the subjects' identities will be guaranteed so that they are not put into any position in which they will be placed on a list to participate in some future study (Yin, 2018). The interviews will be audio-recorded once consent has been sought and transcribed afterwards, where the data will be anonymised. This data will be stored securely to ensure confidentiality and privacy and will only be used for research purposes (Brereton et al., 2008). For analysing the data in the context of this research, the names are not used in the transcript and aliases or pseudonyms are used to avoid potential ethical issues during the data collection and to protect the privacy and confidentiality of the subjects.

Fifth, the subjects for this study are selected equitably, not to include or exclude groups of people (Yin, 2018). This is achieved by explicitly defining the selection criteria on case and subject levels. No vulnerable groups were interviewed in this research.

4.5 Conclusion

This chapter introduced the research philosophy and methodology of this research. First, the research philosophy and ontological assumptions taken have been outlined. Here, this research adopts an interpretive stance backed up by ANT. Second, the research methodology of this research has been introduced. This research adopts the DSR of Hevner (2007) in combination with the multiple case study research of Yin (2018). Then, the case study protocol has been explicitly described. The case study protocol presented all data collection and analysis strategies used for the field research. Here a question design of three parts and multi-cycle deductive coding has been introduced. In the next chapter, these results of the interview questions, in combination with the conceptual framework, will serve as a foundation for evaluation with empirical data.

5 Results: Cross-Case Evidence of Actor Networks and Barriers

This chapter examines the findings of the conducted case studies. Thus, this chapter constitutes the feedback and evaluation phase of DSR. In preparation for this chapter, pilot interviews have been conducted (*see* Appendix E). These pilot interviews revealed that developing individual actor network artefacts based on publicly available data is helpful. To present these results, this chapter is divided into the following sections:

First, Section 5.1 presents the within-case analyses from the individual cases, reporting the findings from nine case studies and additional perspectives of MaaS experts across Europe. This is the basis for a more synthesised evaluation of the results in this chapter. Then, Section 5.2 reports the findings from the cross-case analysis of the actor networks. Here, the findings are presented and evaluated using the four moments of translation of ANT: Problematisation, Interessement, Enrolment and Mobilisation. Specifically, it is presented how the participants of this study are developing their MaaS business ecosystem. After that, Section 5.3 evaluates the cross-case barrier results by comparing the empirical findings with the derived characteristics from the literature. Then, similarities and differences between literature are identified and critically appraised. Here, the barriers to technology, data, social and cultural, and policy and regulation are evaluated. Then, Section 5.4 prepares for the discussion by selecting the key patterns in the three thematic areas. Patterns are selected on the rationale that these patterns provide new information for the state of knowledge or have implications for management. Finally, Section 5.5 concludes the cross-case findings and patterns in preparation for the discussion.

A First Glance at the Data Corpus using a Word Cloud

Before jumping into the results, a word cloud has been created using NVivo in Figure 18. This word cloud visualises the 100 most frequently used words. The size of the words indicates the frequency of them. The world cloud thus provides a comprehensive and intuitive overview of the most often words.

Looking at the most frequently used words, 'mobility', 'service', 'transport' and 'platform' are frequently mentioned, but also 'challenges', 'problems' and the theme of 'ecosystem'. This reflects that the general topic of the research addressing barriers and the ecosystem is very well represented in the data corpus. In addition to that, several challenges are also identified, including 'integration', 'ticketing' and 'funding'.

Figure 18. Word Cloud of the Case Studies

5.1 Within Case Reports - Evidence from the Individual Cases

This section includes the reports of the individual case studies. The individual cases are structured using ANT. Each moment of translation has been mapped to the interview protocol questions. These protocol questions can be found in Appendix E.

First, each case starts with the problematisation. Here the case context and the definitions of MaaS and its business ecosystem are introduced. This is mapped to questions A2 and A3 of the interview guide.

Then, the interessement and enrolment strategies of the actor network are analysed. This is reflected in questions B1, B2 and B3 of the interview guide.

The analysis and interpretation focus on the networks of actors and technologies involved in the case and show how these networks are shaped by investigating barriers. Most of those barriers are deductive, while some are inductive.

Finally, the interview guide emphasises the mobilisation following questions C1, C2 and C3. Here, strategies to overcome the barriers and the individual MaaS future visions are introduced. Thus, the process is described by which actors work together to achieve a particular goal or objective.

Table 12 presents the different cases, including their description and assigns them with the interview IDs to the participants of this study. All data has been anonymised according to the ethical considerations introduced in Section 4.4.5. These different anonymised cases are now introduced, and key observations and insights are derived in the within-case analysis.

Table 12. Case IDs and their Description mapped with Interview IDs

Case IDs	*Case Description (Anonymised)*	*Interview IDs*
CS1	A German City MaaS Platform	I1
CS2	A Swiss Multi-City MaaS Platform	I2, I3
CS3	A German City MaaS Platform	I9
CS4	A Scottish Multi-City MaaS Platform	I5
CS5	English Multi-City MaaS Platforms	I10, I15, I16, I18
CS6	A Dutch Multi-City MaaS Platform	I13
CS7	A Czech City MaaS Platform	I14
CS8	A Lithuanian City MaaS Platform	I6
CS9	A Hungarian City MaaS Platform	I11
CS+	Additional international experiences from legislation, consultancies and early MaaS platform planning in Europe.	I4, I7, I8, I12, I17

5.1.1 Case Study 1: A German City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

Case Study 1 (CS1) was conducted with I1. CS1 was launched based on a previous pilot with the "desire to launch an app relatively soon that offers different Mobility Service Providers (MSPs) in a deeply integrated way to customers and we have used a software solution for this" (I1). The goal of CS1 is to "strengthen public transport plus the environmental network, for example, everything that is not individual transport, in order to ultimately support the major goal of the mobility transition" (I1). Thus, the focus of CS1 has been on the "first" and "last" mile. I1 understands MaaS as "simple access to mobility that is as barrier-free and obstacle-free as possible, which should function independently of the means of transport and ultimately also independent of the provider” (I1).This definition contains various aspects, from Giesecke et al. (2016), such as the "nature of travel", the "end-user perspective", and the "sustainability" aspect. For comparison with the MaaS definition of Jittrapirom et al. (2017), the ideas such as One-Platform, Multiple-Actors and the registration requirement are also included. The business ecosystem is described from the perspective of a classic public-private partnership. Various mobility service providers are mentioned here. I1 mentions local public transport (ÖPNV), for example, the classic underground, bus and tram, as one of the public mobility providers.

Interessement (Case Approach)

After the pilot, CS1 decided to set up its own MaaS system, "we already had a ticketing module [...], we had routing via DEFAS [...] and were already tackling the issue of multimodal routing for other solutions. In other words, we essentially had relatively much, and the commercial software provider had only offered a platform solution in the end” (I1). One difficulty was to use individual components of the platform that function independently of each other in a modular way. Since this was impossible and many components were already available, CS1 was further developed after the pilot. After deciding to continue the pilot, "a kind of application procedure was advertised, and we thought about what requirements an MSP should and must meet to be able to integrate with us” (I1). Here, transport-related criteria such as a suitable and comprehensive mobility mix were considered, and other requirements such as data security, data protection rules and transparency rules were defined. These rules were the core requirements to be considered as a partner. The company's location also played a role in the selection of the MSPs, as the same framework conditions apply to them. The barrier volatility of the market was also looked at more closely in the selection process.

Since often "ownership likes to change, but also the business models" (I1). Also, I1 sees margin and business models as complex, as margins are very tightly planned and see the need to finance business models publicly. No additional interest in the solution had to be aroused since CS1 is "known and present as a municipal company anyway" (I1). For I1, the decisive point “is the size and the role as a neutral player”. Since CS1 has a robust internal IT, decisions were made years ago to set up its ticket shop in order to be "independent of larger providers [...] and to be able to be faster and more individual in the configuration" (I1). A Single Sign On (SSO) was also developed in-house, making consuming various service offers possible with one login. An interesting tactic to observe is that the topic of parking was also integrated early on. Public transport stops are displayed so that "this barrier between the worlds is also minimised as much as possible and to say that the step into the environmental network is simple and the Login is stored there as a single sign-on for both" (I1).

Enrolment (Actor Integration and Onboarding)

The MSPs were generally perceived to be willing to integrate into the platform since CS1 has a broad customer base with their login. The integration also incurs costs and efforts that the MaaS provider itself bears. This means "that we are ultimately stuck with most of the costs ourselves, because the majority of expenses are occurring naturally on our end" (I1). It was also observed that more municipalities would like to build similar MaaS platforms, and that the integration is associated with high expenses for MSPs. Therefore, according to I1, there must be "some kind of standardisation" (I1). I1 refers to the networking initiative Mobility Insight, which sets up a platform throughout Germany to establish a nationwide standard interface.

The question here is why German cities have not already established a standard-ised integration: "it does not make sense to have to do it again yourself and pay the as-sociated effort and costs" (I1). For CS1, a deep integration was aimed.

Validation services are also included via the login so that customers can only enter their data once but can use all services. A challenge observed here was with so-called specials and bundles, which could only be offered with difficulty. However, from the point of view of I1, this is not so important, as CS1 explicitly addresses customers "who really travel multimodally and don't want to specify themselves to one manufacturer or to one service provider" (I1). Another challenge mentioned by I1 was car sharing, as a deep integration is very difficult to realise and cannot be demanded by car sharers at the moment. Here, I1 recommends that it would make sense to "tender a kind of concession" to "require the integration on the municipal platform along with it, so to speak" (I1). In this way, a framework could be set that will be used in future tenders so that integration is seen as a prerequisite if the MSP wants to offer services in the respective city.

In general, a high acceptance of the users concerning CS1 was observed, "the ratings of our apps in the app store are above average in relation to others" (I1). Inclusion was also important, targeting the service to older population groups, making it easier for them to consume digital mobility services.

Key Barriers, Strategies, Learnings, and Future Vision

The most significant barrier mentioned was a technical one. Changing rules, which must be mapped technically via geofences, for example. Particularly in the case of larger events, prohibited zones sometimes even change daily. Here, these zones were tapped dynamically from various sources.

A learning I1 referred to was that with the commercial software provider, "we rather built up, understood and practised this contractual constellation in the background" (I1). Because of that, the focus of CS1 was not on the technology. The main barriers had been the policy part "dealing with the contractual legal part" (I1). In addition, I1 suggests "to tender for a kind of concession, especially for car sharing, but also for the others, and then demand the integration into the municipal platform" (I1). This strategy enables them to get this permanent volatility under control differently. I1 sees the future as one in which the needs of citizens are better interconnected. Mobility is one part of these needs. In addition, integrating everything and creating easier transitions is challenging. One can consume mobility via the platform and book a cinema or concert ticket with one login. A mindset change towards certain forms of mobility must happen here. Also, the market will saturate in the future, and a few actors for mobility will establish themselves. As a technical factor, intermodal routing will also have to advance, and entire route chains will have to be routed "with a reliability that my next vehicle will really be there" (I1).

CS1 Summary including the Actor Network

Table 13 highlights and summarises the main themes, including key observations and insights of CS1.

Table 13. Summary of Individual Themes of CS1

Themes	***Key Observations and Insights***
Problematisation	➢ CS1 was launched based on a previous pilot. ➢ The goal has been to launch an app using an existing commercial solution. ➢ Focus has been on the support of first and last mile.

Interessement	➢ Became independent from the commercial solution. ➢ Requirements for potential MSPs were defined. ➢ No additional interest had to be aroused.
Enrolment	➢ MSPs have been willing to integrate because of the existing large user base. ➢ High integration and maintenance efforts were observed. ➢ Deep integration was aimed for.
Mobilisation	➢ Strong user base and acceptance. ➢ Inclusion agenda has been a big topic.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Policy barriers: Volatility of the market resulting in changing rules for real-time data and standardisation of data exchange. ➢ Strategy: Establish a deep integration with MSPs, tender and require concessions for MSPs.
Learnings and Future Vision	➢ Mindset change is required. ➢ Modularity: One platform, one login to do everything. ➢ Technical advancements need to guarantee reliability.

Figure 19 shows the actor network generated based on the encounter from the SLR and has been anonymised and colour-coded for the actors who constitute CS1.

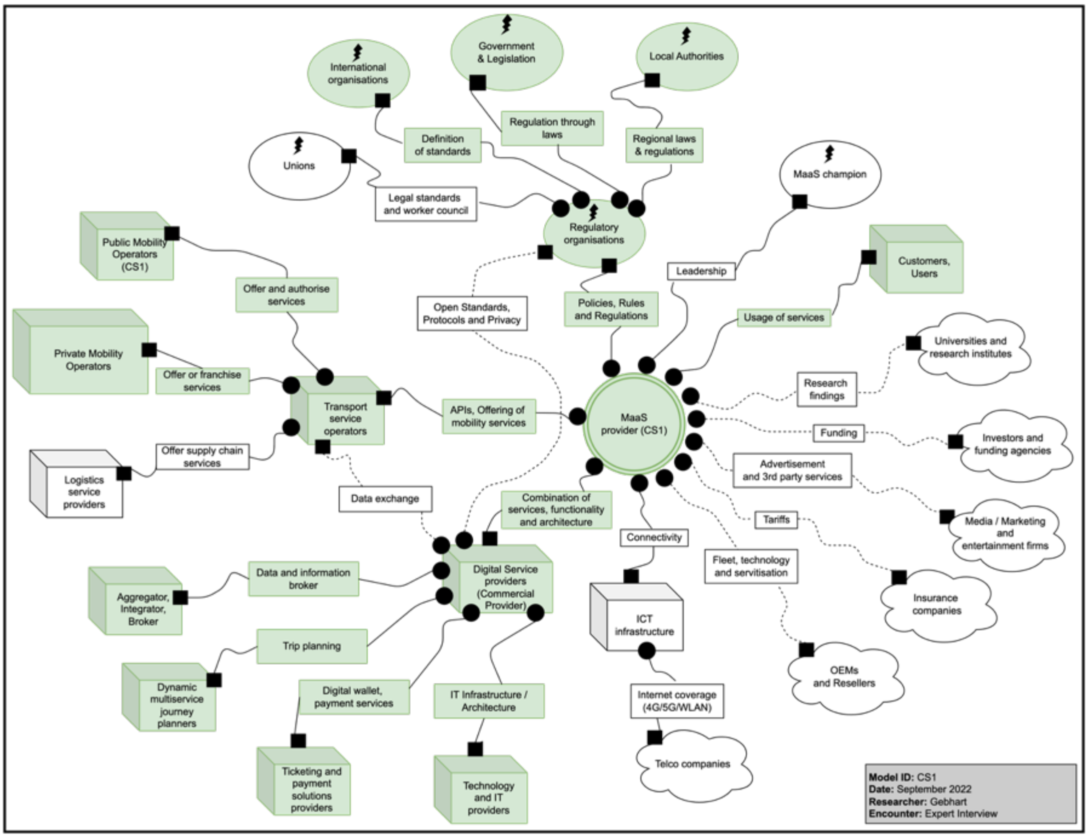


Figure 19. MaaS Business Ecosystem Actor Network CS1

5.1.2 Case Study 2: A Swiss Multi-City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS2 was conducted with I2 and I3. CS2 started with the aim of "testing subscriptions, for example bundling different means of transport and offering them to people at a fixed monthly price" (I2). Here, the urban population was the focus of CS2. Previously, a similar pilot focused on the residents in the surrounding area of the city. At that time, the focus was on addressing park-and-ride car parks in order to travel from there into the city. However, this did not focus on urban residents. CS2 has been a multi-city platform of four different cities in Switzerland. Of the four participating cities, the motivations to participate were different. However, they all recognised the potential of MaaS, not with the aim of "making money, but as a steering instrument for mobility in cities and agglomerations" (I2). Because as I2 also mentions, "we don't get money if you offer the customer a better solution" (I2). So, the desire was there to try MaaS, but only minimal financial resources were available. By having several cities participate in this pilot, it was possible to spread the effort. In the context of CS2, I2 defines MaaS "as the use of different modes of transport as easily and hurdle free as possible to organise one's private mobility or professional mobility" (I2). I3 emphasises that MaaS can be defined in many different ways. In this context, I3 sees "the main concept of MaaS as putting the user at the centre and being able to provide him with all mobility solutions from one source on one platform as simply as possible [...]. So, the user can choose the means of transport to get from A to B and have access including billing" (I3). Considering the business ecosystem, "the backbone for MaaS is still public transport" (I3). In this context, the public MSPs must necessarily be on board of a MaaS solution.

From I3's point of view, the private MSPs are "the next stage of expansion […] where the whole offer becomes more attractive for the users" (I3).

Interessement (Case Approach)

Actors were interested in the MaaS solution because of its prominent name and because they "also meet each other at industry events where they have the exchange" (I3). It was pointed out to the potential actors that it would be an extra sales channel for them and that they would also receive learnings from it and would thus be among the "first movers" (I3). For the partners who were not yet technically ready, it was promised that they would be helped "to make their APIs ready, be it with technical know-how or also with financial support" (I3). A simple company was founded for the project, consisting of the three largest cities in German-speaking Switzerland. Before the project started, customer surveys and market research were conducted, asking, "what should be in such a platform?" (I3). In this way, those responsible at CS2 knew in the conception phase what was "demanded on the market or what combinations were desirable" (I3). At the beginning of the project, the focus was on public transport; private MSPs were an add-on. Also, the market in Switzerland was limited at the time of the pilot "we had no e-scooters at that time, we had car sharing, along with public transport, bike sharing and that was it" (I3). For the CS2 pilot, market research was first carried out, and then, after a call for tenders, a digital service provider was engaged.

Enrolment (Actor Integration and Onboarding)

First, CS2 thought about "which ones do we want to talk to now, what fits, and what do we have here and does it work" (I3). When selecting providers, it was also said that "we don't need more of the same, but rather we want to see how mobility behaviour changes" (I3).

The mobility portfolio comprised public transport operators and private MSPs (car sharing, bike sharing, cargo bikes and e-scooters). There was additional thought about integrating parking with gates, but it was "then decided against, also considering the time and what we can learn" (I3). To integrate the different actors, active partner management was done. There was a different commercial model in which "two types of contracts" (I2) were included. In the first step, there was a Letter of Intent (LOI) saying, "we want to support, and we will also communicate together and so on" (I2). Then, in the second step, there was a commercial contract determining the tariffs and compensation. The project was started by integrating car sharing. Then bike sharing was tackled, but there was a challenge here in that the provider with the most extensive network had "an outdated infrastructure" (I3). After six months of the project, "the E-Trotti providers came to Switzerland and Voi and Tier could be connected" (I3). In addition, due to time and budget limitations, the project was limited to a maximum of eight MSPs. The goal was to create a level 3 integration, which means that "ideally, the booking, the payment [...] and also the reservation must all be possible without jumping off in the MaaS app" (I2). Although an international standard was available from the commercial software provider, this still led to high costs for the participating MSPs. Barriers arose with some private MSPs, as there were no taxi providers "who would have had the API ready in that time, which was needed for the deep integration" (I3). The digital service provider always did the integration and enrolment and looked at the potential MSPs to be integrated and implemented in the APIs.

Mobilisation (Activities and Evolvement of the Network)

Based on the project's prominence, "many also approached us and asked, may we integrate?" (I3).

This fact shows that a certain pull effect was achieved as soon as a critical mass of awareness was reached. Though, no activities regarding regulation discussion were started "we did not focus on that" (I3). However, it was said, "we take the MSPs that exist locally, but we hold back from discussing with the city whether they allow an MSP in the city" (I3). The potential for optimisation was reported back to the city "to not make life more difficult for future MaaS platforms if they want to come to the city" (I3). On the user side, the MaaS platform was generally very well received. One challenge, however, was "that we appeared with a completely different name" (I3). Due to this lack of awareness, winning over customers for the platform was initially tricky, as there was also no large-scale advertising. There were also additional thoughts and ideas about what else could be done with CS2. However, there were financing problems on the part of the partners, so they would like to use the lessons learned for the time being and then move on to a second project.

Key Barriers, Strategies, Learnings and Future Vision

For I2, the most significant barriers have been in the social area, including market demand and user acceptance. These barriers are underlined by acknowledging that “a new product, a MaaS subscription, a new brand takes time, a one-year pilot is far too short. It takes three to four years, especially if you then want to change the modal split of the car owner.” (I2). For I3, the main barriers have been to create business models including subscriptions “the biggest barrier is to somehow make it all calculable with the pricing systems and right for everyone, including us in the billing at the end” (I3). Here the strategy has been to “bring all the MSPs concerned to a table where we discussed them together, and you always felt a lot of goodwill and openness from all participants” (I3).

The central learning has been that cities must move to the centre of mobilisation so that an overarching mobility strategy for agglomerations can be defined and transparent processes for managing the mobility landscape and demand are established. Through CS2, the decision makers were "forced to think about a mobility strategy for the city, or for the agglomeration" (I2).

For the future, I3 mentioned that "a critical mass somehow before the offering is accepted at all, perhaps also by the customers" (I3) is required. The vision of I3 reflects a modular MaaS platform: "that when I live somewhere, I can access a MaaS platform and just have everything in there that I need for my daily life. That can also go beyond mobility. Where I can perhaps also order things or call them up" (I3). According to I2, "the ecosystem of the future must be designed fairly so that all actors have the same opportunities to offer mobility with regard to sustainability" (I2).

CS2 Summary including the Actor Network

Table 14. Summary of Individual Themes of CS2

Themes	*Key Observations and Insights*
Problematisation	➢ Four participating cities in Switzerland. ➢ Focus on urban residents and explore MaaS. ➢ Business Ecosystem: Public MSPs first, then private MSPs.
Interessement	➢ Actors were interested in the prominent name of CS2. ➢ Founding of a combined company. ➢ Outlining the benefits of joining.
Enrolment	➢ Prioritisation strategy to build a diverse portfolio of MSPs. ➢ Active partner management with contractual management. ➢ Deep integration, LVL3, was aimed.

Mobilisation	➢ Network effects were observed. ➢ No activities regarding regulation were started. ➢ Branding has been challenging.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Market demand and acceptance of users. ➢ Strategy: Acknowledging that change needs time, longer-lasting evidence is required. ➢ Creating Business Models and bundles. ➢ Strategy: Discussion tables with all MSPs involved.
Learnings and Future Vision	➢ Cities must be the centre of mobilisation, having an overarching mobility strategy. ➢ Critical Mass of MSPs is required. ➢ A modular inclusive platform that goes beyond mobility.

Figure 20 depicts the actor network of CS2. The digital service provider has been a commercial company, multiple MSPs (both public and private), a research institute and different users were involved.

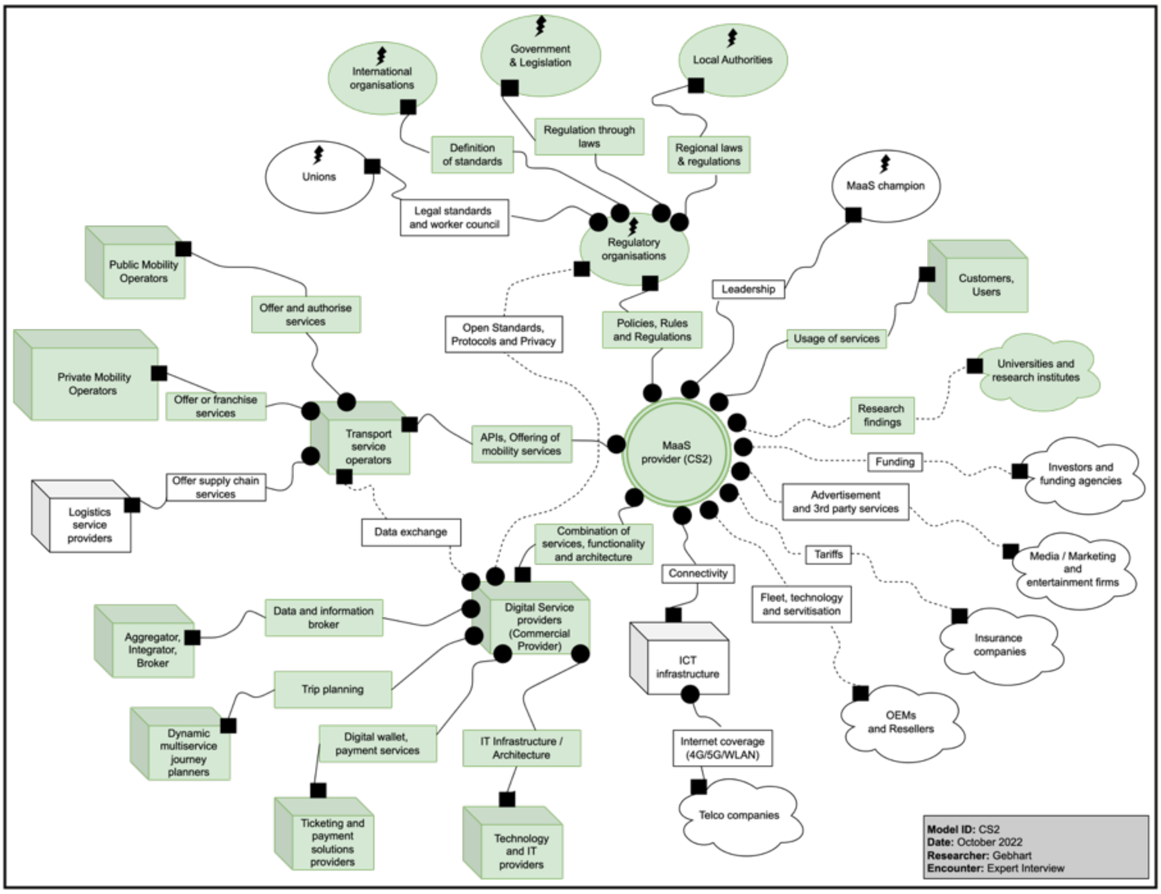


Figure 20. MaaS Business Ecosystem Actor Network CS2

5.1.3 Case Study 3: A German City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS3 is the most advanced MaaS platform project in Germany. The project is led by a public service provider and is recognised as an integral part of their business. This fact enabled to fund a separate department, and according to I9, this "helps to push CS3 forward with this departmental bang" (I9). By this department, two things have been done. On the one hand, the department ensures "that our MaaS solution runs, that everything works" (I9). On the other hand, the department ensures "that we develop the topic further […] that we continue to improve the user experience, […] so that we remain competitive, […] because the market is very volatile and many offers enter the market, leave the market and so on" (I9). As a result of these activities the MaaS platform is broadly-based and addressed distinctively on such a large scale. MaaS is defined from a user-centric perspective by I9: "for us, MaaS means on the whole that no matter what my mobility needs are, I can get the right vehicle, the right offer, at any time and for any need, and that I can use and book it at a very low threshold" (I9). This definition has two meanings. First, it covers the mobility needs. This means that the MaaS platform has to cover a critical mass. This is recognised by I9 "we need, and we have all the mobility and all the modes that are available in our solution" (I9). Second, this definition implies that the mobility offerings do exist outside of the MaaS solution. I9 describes that "these offerings are their own companies, their own players who also have their own apps and also put a lot of time, money and manpower/womanpower into their respective offerings" (I9). However, what is added by CS3 is the "topic of the ecosystem […], we bundle these offerings and enable users to use them with a single login and registration" (I9). This bundling of services is considered the business ecosystem by I9.

As this creates comparability of the service offerings "neutrality is also an important aspect […], as far as mobility is concerned, we see ourselves as a spider in the web […], we don't see our mission as favouring one player or another. We can't do that, and we can't legally do that" (I9).

Interessement (Case Approach)

CS3 started with a pilot and then went into a call for tender. Here CS3 was searching for a “strategic partnership” in the form of “a cooperation project” (I9). CS3 then awarded a commercial digital service provider to supply the platform. To make sure that potential actors willing to join the platform are treated neutrally, CS3 established “a continuous interest expression procedure, which is a kind of call for tender that we have continuously publish and also update, in which we invite all mobility providers to express their interest in being part of the (CS3) network” (I9). This procedure has been made public and actors interested in joining the network can have a look at it. In this procedure “different criteria are defined for each mode to be fulfilled including the interface, size of their fleet and growth strategy” (I9). This approach is unique compared to other platforms interviewed because of the size of the platform. A critical success factor has been the partner management and appeal of CS3. There is a regular “exchange with all mobility providers. You can assume if there is a new player on the market, our partner manager has already spoken with them, knows them and is in exchange with them” (I9).

Enrolment (Actor Integration and Onboarding)

Actors are integrated and prioritised based on the criteria catalogue. Once in the funnel, “there are of course technical requirements that must first be fulfilled on their side, such as the authorisation of all interfaces […]. Depending on the degree of fulfilment, the providers move up the implementation roadmap, so to speak” (I9).

The process starts with a letter of intent which “clarifies each other’s requirement and says that we can and want to work together” (I9). Then contractual challenges must be resolved. This includes “things like the platform and the business […], which means that we also provider certain services centrally, such as payment or verification services. […] Our providers have to accept that level of service” (I9). This is required to connect accordingly and to provide the technical support needed. This deep connection requires technical work, which “is done by our platform partner, who providers the platform technically” (I9). CS3 is not employing any developers. However, “the whole issues of onboarding, the whole issue of accompanying the process runs with us” (I9). Making the platform capable of certain things by “making backends talk to each other, enabling booking, enabling payments, enabling refunds” (I9) is considered as a challenge. I9 refers to the onboarding process as classical project management tasks. It comes with “classic challenges that arise from project management in the broadest sense […]. All the providers have their own development goals” (I9). That makes it challenging to coordinate the enrolment process.

Mobilisation (Activities and Evolvement of the Network)

Regarding mobilisation, I9 says that “we see a fundamental growth in use” (I9). Whenever CS3 releases a new feature or goes live with new providers or stations, “we see that there is also an impulse there” (I9). This network evolution is mainly caused by spokespersons, also called MaaS champions. According to I9, these are internal people like the CIO “who also leads the area in which we are suspended and has become the CIO of the year […] being visible, attracting conversations with new players” (I9) and the active partner manager who “holds talks to draw attention to the interest procedure” (I9).

Key Barriers, Strategies, Learnings and Future Vision

A key barrier named by I9 has been "classic conflicts of interest, or conflicts of resources" (I9). Conflict of interest could be caused when something technically changes in the CS3 platform or new functions are implemented. That means that "all providers must also change something in order to be able to use it in the future and to be able to participate in the advantages that we expect from it" (I9). The strategy to overcome this barrier is to "clearly point out what the advantages are and what the disadvantages are" (I9). Other learnings responsible for the success of CS3 include the creation of mobility hubs which are "a physical mobility station network in the city, which allows to anchor the topic in the city" (I9). CS3 exercises political opportunism, meaning that "it is politically opportune for the providers to at least get in touch with (CS3)" (I9) because CS3 is anchored in the city's transport contract. In addition, a strong brand and market size has been key learning and success factor for CS3, "everyone is here. Everyone who is active in German is usually also active in (CS3) […], we simply have a wide range" (I9). The future vision of CS3 is to implement functions to scale better and to incentivise mobility. According to I9, this can be achieved by making the "platform better in the sense of being strong as a module, stronger as a hub between the providers" (I9). Modules must be exchangeable and standardised, allowing "onboarding new providers more quickly" (I9). In addition, I9 mentions that the platform could be used and has already been used as a control instrument for mobility in the city. For example, if an event happens, "we can react to things that happen in the city and that mobility requirements also arise in the city for a limited period of time" (I9). This also enables far future a tool for city planning that "we always have in mind from an urban planning perspective" (I9).

CS3 Summary including the Actor Network

Table 15. Summary of Individual Themes of CS3

Themes	*Key Observations and Insights*
Problematisation	➢ Most advanced MaaS platform project in Germany. ➢ Own department in the organisation has been funded. ➢ Critical mass: All players operate in the city.
Interessement	➢ Started with a pilot and then tendered the platform. ➢ Continuous interest expression procedure for interested partners. ➢ Active partner management.
Enrolment	➢ Actors are integrated depending on their fulfilment profile with the criteria catalogue. ➢ First LOI, then contract, then classic project management.
Mobilisation	➢ Fundamental growth is observed. ➢ Spokespersons or MaaS Champions helping the evolvement of the network.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Interest conflicts and conflicts of resources. ➢ Strategy: Pointing out advantages and clear prioritisation. ➢ Coordination of different partners and project management.
Learnings and Future Vision	➢ Mobility Hubs are spread in the city to anchor the topic. ➢ Political opportunism, being anchored in the city's transport contract. ➢ Strong brand and markets size has been a success factor. ➢ The future will be more modular, standardised and exchangeable. ➢ MaaS can be used as a control instrument and as a tool for city planning.

Figure 21 depicts the actor network of CS3. The digital service provider has been a commercial company, multiple MSPs (both public and private), a research institute and different users were involved.

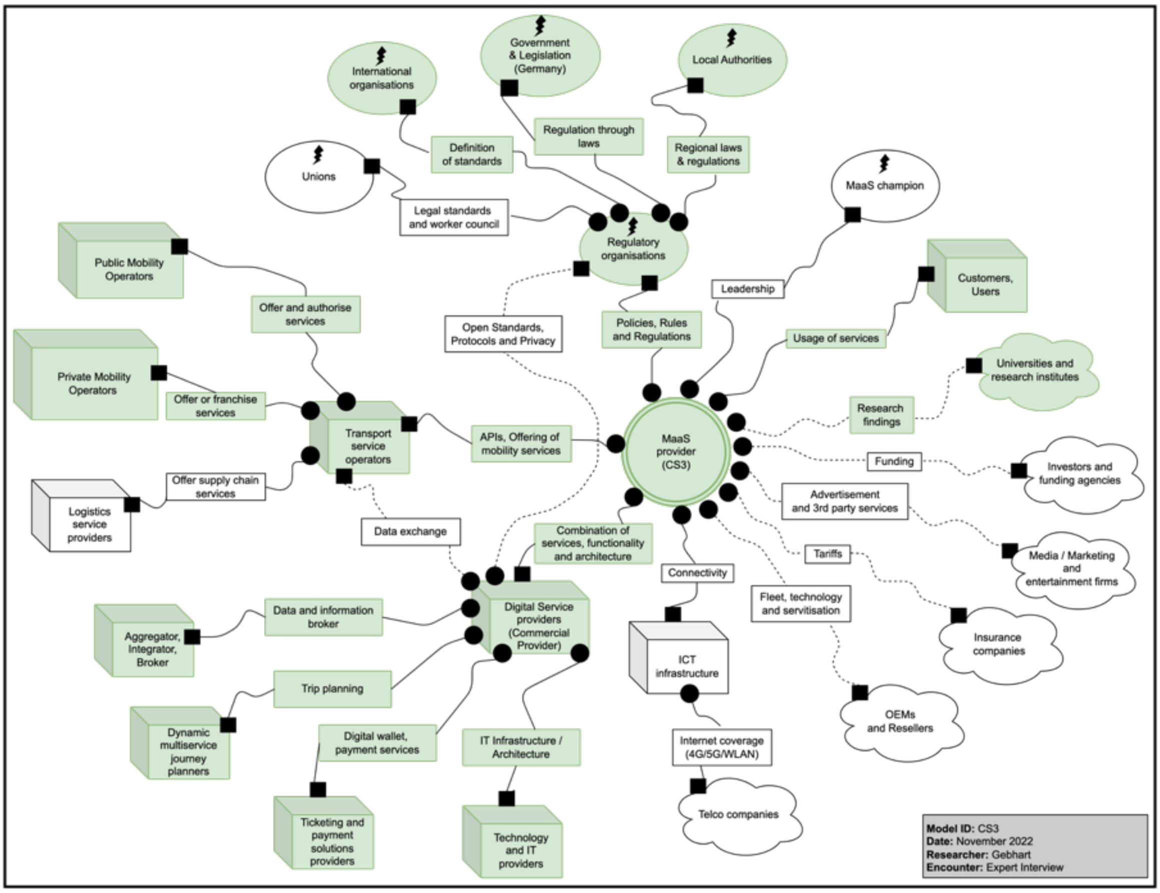


Figure 21. MaaS Business Ecosystem Actor Network CS3

5.1.4 Case Study 4: A Scottish Multi-City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS4 has been conducted with a Scottish MaaS platform that helps public sector organisations in Scotland to "quickly launch and manage their own MaaS offer to whomever their target audiences" (I5). In Scotland, "there are 32 local authorities […], so each regional transport partnership has a collection of local authorities that they represent" (I5). These authorities are targeted by CS4 being in a regional transport partnership. These partnerships already have "a relationship with the relevant people who are responsible for transport within each of those authorities" (I5). Because of the different sizes of those local authorities, not all cities "may have a dedicated transport team within that local authority (I5). For this reason, the MaaS platform is developed with a regional transport partnership (I5). The regulation for this partnership is set by "Transport Scotland, the national transport body for Scotland" (I5). I5 emphasises the different definitions of MaaS which exist. In the context of CS4, I5 describes it "we define MaaS all transport in one place so that a user can compare all the transport network in one go" (I5). From a user perspective, the user can plan the journey and "make an informed decision based on all of the different options that are available in my transport network, including, at a minimum, journey times, price comparison or fairs" (I5). The results are personalised for the users, and tickets can be paid contactless. I5 thinks that a good value proposition is needed for users to use it: "in terms of the value created for the end-user, I think most of it is in the comparison side of things" (I5).

In terms of the ecosystem, it is approached by CS4 that the MaaS platform can be quickly adapted. That means that "public sector organisations and private sector organisations who want to run their own MaaS service" (I5) can quickly integrate.

I5 mentions that "there are a variety of other stakeholders involved in each pilot, some are common amongst all the pilots, and some are specific to each MaaS implementation" (I5).

Interessement (Case Approach)

Getting other actors interested in joining the solution “goes back to the common actors and the unique actors for each implementation” (I5). CS4 has already developed a foundation of actors who are part of the ecosystem and thus interests other actors to join because they can see the value. Those actors who are already part of the platform are “willing to work with us on other projects” (I5). If a new local authority is interested, they can use those actors. However, each implementation differs as each local authority has “a set of relationships and stakeholders they want to work with” (I5). For this reason, getting other actors interested in joining CS4 is not required in the commercial model, as it is written that a “particular set of stakeholders […] (CS4) want to work with” (I5).

Enrolment (Actor Integration and Onboarding)

However, specific technical requirements must be fulfilled to integrate the actors with the MaaS platform. Actors are required to open their APIs: “if there are of a certain size, they have to provider their information, their placing, information and their timetable information to a nation service run by Transport Scotland, which is who we plug into” (I5). However, some “local authority tend to go and procure their own schemes” which requires “to integrate more sources of information” (I5). The prioritisation of integrating new actors comes from a decision of the regional transport partnership. CS5 started with the integration of demand-responsive transport (DRT).

Here, the main challenges are “an agreement to integrate […], either come through contractual, or you are the provider to this local authority, and in your contract, you must provide the data to them so that they can do that” (I5). After this agreement has been set up, the digital service provider investigates the required integration details. This includes the investigation of APIs, NDAs, and cost estimates.

Mobilisation (Activities and Evolvement of the Network)

CS4 is still at the very beginning, but “what we would like to see is one platform that has all the transport operators, or information required integrated across a country, Scotland or the UK” (I5). Mobilisation happens currently in the network by establishing an ecosystem with local authorities which work together in regional transport partnerships. A blocker for growth observed is the restrictions of micro-mobility in Scotland: “we don’t have any micro mobility and we don’t have any scooter trials in Scotland. The regulation doesn’t support that here” (I5).

Key Barriers, Strategies, Learnings and Future Vision

In terms of key barriers, I5 observes technical readiness challenges for some local mobility operators “the challenge is these small, and sometimes informal organisations don’t have APIs; they don’t even have booking systems. Sometimes you know it is a piece of paper or an Excel spreadsheet” (I5). This makes it difficult to integrate certain actors into the platform of CS4. This barrier is currently overcome by I5 by speaking to these operators about “how they might want to be presented in a journey planner and then created a local database for them to be able to be included within the system without having to develop anything themselves other than just provider the information” (I5). As a result, key learnings have been that regulations would be needed that require every operator to have an API and if they have one to expose it.

Further, it is recommended by I5 to clearly "write into the tender the contract requirements that they must provider an API with locations, price, availability et cetera" (I5). This also helps the local authorities to define standards to be able to say, "if you want to come and play in our area, you need to be able to integrate with this system" (I5). Another strategy has been to integrate with aggregators wherever possible as "they have their own contracts and things with different fleets around Europe, meaning we don't have to do deep integrations with them; we use their platform" (I5). This helps to "get up and running more quickly" (I5). For the future I5 envisions a true meta app for mobility that enables "public sector organisation, the regional transport partnership having a tool that allows their target policy resident, whoever they are targeting, to be able to make the most of their transport network" (I5). This enables a tool for city planning "to compare your transport network and all the things that are going on here […], a one stop shop" (I5). This can then be backed up by "numeric evidence to support a business case to put in a new transport operator […], to see there is a transport network gap from this town to this town" (I5). In terms of the platform, it is assumed that in the future "there would be a national front end plugged into that platform, but alongside that, there would be these other apps that use the common components with their own unique elements to them" (I5).

CS4 Summary including the Actor Network

Table 16. Summary of Individual Themes of CS4

Themes	***Key Observations and Insights***
Problematisation	➢ Regional transport partnership consisting of multiple local authorities. ➢ The goal is a multi-regional MaaS platform. ➢ There are common actors involved and specific actors.
Interessement	➢ The actors are part of contractual agreements in the regional transport partnership. ➢ The commercial model governs the platform actors.
Enrolment	➢ Technical requirements for integrating. ➢ Prioritisation comes from the regional transport partnership. ➢ Digital service provider investigates the technical details.
Mobilisation	➢ Starting to mobilise, critical mass is required. ➢ The established MaaS platform mobilises in a regional transport partnership. ➢ Micromobility is not available in Scotland.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Technical readiness concerning small mobility operators. ➢ Help them to develop a rudimentary API. ➢ Policy to develop APIs would help to streamline the development.
Learnings and Future Vision	➢ Regulations and policies would help. ➢ Clearly stating the integration requirements in the contract. ➢ Integration with aggregators rather than single mobility operators. ➢ The future is envisioned with a true meta app for mobility and from a city planning perspective.

Figure 22 depicts the actor network of CS4. The digital service provider has been a commercial company, multiple MSPs (both public and private) are involved, and the project has been funded through Transport of Scotland's MaaS Investment Fund.

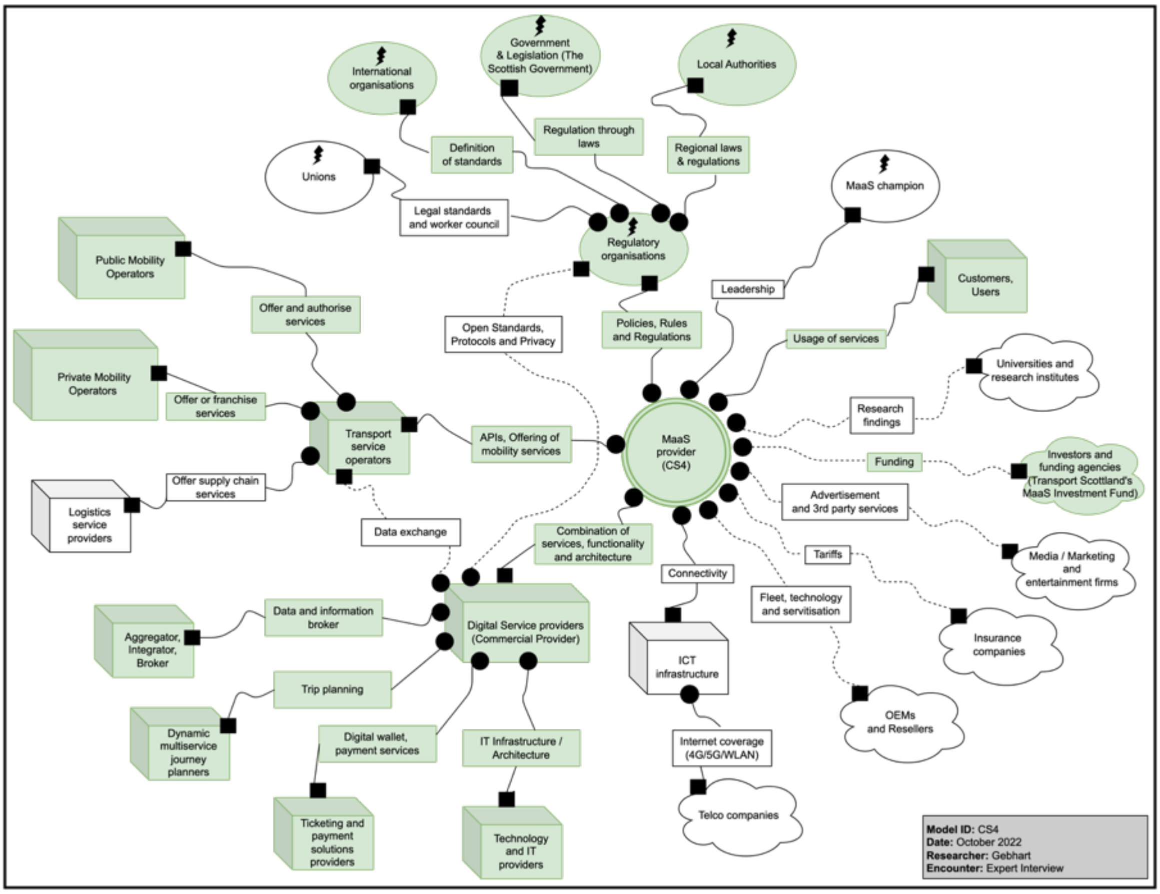


Figure 22. MaaS Business Ecosystem Actor Network CS4

5.1.5 Case Study 5: English MaaS Multi-City Platforms

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS5 is a collection of different experiences and projects combined into one case. CS5 consists of four interviews I10, I15, I16 and I18. Those interviews have been summarised into one case study because the findings have been mostly similar between the different cases. Thus, CS5 can be seen as a cross-case examination of English MaaS multi-city platforms working in individual combined authorities.

Regarding problematisation, I10, I15, I16 and I18 remark that the goal has been to pilot MaaS and see its impact.

I10: "target the region, doing lots of research, trials, testing and true implementation."

I15: "we have this goal to become a lot more integrated."

I16: "we kicked off a series of pilots to collect evidence on what does a MaaS offering look like?"

I18: "our goal was to trial MaaS, testing it to see what impact it has and how it can be developed further in the UK."

For I10, the key has been integration with an "integrated back office" (I10), going beyond just a frontend system. This enables "a data-led tool to influence behaviour change inciting a modal shift" (I10). The initial vision for MaaS of CS5 has been to "deliver an integrated, collaborative, end-to-end journey planner for the region […] including booking, ticketing and payment functionality with contextual information relevant to them" (I18). I18 started to "define what we want from MaaS and the specification for the existing platform" (I18). For this, I18 worked with "all the different actors in our region to understand what they would like to see from this" (I18).

In terms of the ecosystem, “we look at it as the foundation of public transport […], bus, tram, train, walking, cycling and e-scooter” (I10). Later, “we look at some more interesting things, like the integration of mobility hubs, EV charge points and new modes we don’t even know about” (I10). In contrast, I15 describes their ecosystem as small, “there are a lot of hills, and very small town” (I15). That influences the definition of MaaS and its ecosystem for (I15), highlighting that they want to be seen as a “facilitator in the market” for rail (I15). I15 also mentions some social challenges: "it’s not necessarily always supported by my colleagues or leadership, so it’s an uphill battle to sometimes bring us around” (I15). In comparison, I16 relied on “working with a traditional consultant” (I16) to collect evidence first on how such a MaaS offering could look. This resulted in a first pilot to “understand what the benefits are and who really is the customer” (I16). Here, I16 describes that traditionally it was not the core business of CS5 to create such offerings. Because of that, “understanding where we fit in that MaaS ecosystem has been challenging” (I15). In this context, I15 also highlights the changing skills required to develop and maintain MaaS “traditionally, you know you would have an IT team that will look after these systems as a whole, but increasingly these are could-based services” (I15). Further, as all cases of CS5 are neutral providers, it is essential that “we have to be impartial, as a government organisation” (I15). This traditional organisation has transitioned into MaaS, while the fundamental core of it is “the integration of mobility offerings in the region with digital provision” (I16).

Interessement (Case Approach)

For interested other actors in the MaaS business ecosystem, the starting point for CS5 has been to “simply map out all of the different providers within the ecosystem that are offering mobility services” (I18).

One strategy by I10 has been to look at who “has a big market share” (I10). However, “there were a lot of different stakeholders to bring on board […], and some still are very sceptical about (CS5)” (I15). To overcome this barrier, the strategy has been to bring them to the table to show what “different pilots were doing, what it is going to be about and making them aware” (I16). Thus, these demonstrations have reached higher visibility for CS5, and more actors have become interested. In addition, actors were included “of the process throughout […], we have several working groups already […], any actors that are part of that, which are most of them in the region, are a part of that group” (I10). In these working groups, “we designed the proposition where it required minimal investment from them to get the concept tested so that they could see some results” (I16). CS5 must go through procurement processes “we told the market what we wanted as an outcome […], it was interesting to compare because there were different ideas […], we never have thought of” (I18). I10 describes it as “an app, data integration layer, and a journey planning API so that we can use it within other sorts of technology offers” (I10). However, it was discovered “that most of the providers in the market, if not all of them, couldn’t deliver everything we wanted” (I18). This shows that existing commercial solutions are sometimes not flexible enough for the requirements. That also results from a political and policy barrier “they were used in European transport markets where everything is regulated and delivered by public sector […], we have no control over the buses” (I18). The approach to get them interested has been that “we’ve tried to be clear with operators that we will be fair on the competition point” (I18). That has been understood by “the most operators we have spoken with […], they understood that we don’t want to restrict competition” (I18). Further, they agreed that it should be “led by the public sector” (I18).

However, some actors were not immediately interested because they “aren’t used to working in that way […], they’ve never heard of MaaS” (I18). Here I18 emphasises that “we cannot force them to participate in MaaS […], there is very little regulatory power” (I18). Because of that, it would be helpful to define policies that “power authorities to be able to encourage, require, and enforce MSPs to participate” (I18). One strategy has been to set up “a forum to bring together that ecosystem” (I18).

Enrolment (Actor Integration and Onboarding)

CS5 started by asking the actors “what they want to do from a MaaS perspective in very clear terms of how they see themselves integrating into the region as a whole in the multi-modal setting” (I16). Then CS5 tried to establish a commercial model “we have started the conversation between them and our platform provider around integration and the commercial deal” (I18). Some interviewees of CS5 have just started with that, and others are much more mature. In summary, the learning has been “whilst technical integration is difficult; it’s the commercial constructs around that to enable MaaS are more painful and more difficult to overcome” (I18). I18 adds that sometimes it goes “against long-standing business models and ways of working” (I18). I16 emphasises that bus operators are currently deregulated and “getting them to agree that’s difficult” (I16). However, “we need the permission of the operator to act as an agent to sell tickets on their behalf” (I18). Thus, “we won’t get to any deeper integration like ticket sales or journeys until that franchising process has been implemented” (I16). In general, CS5 started integrating actors with deep links “as a user, you’re sent out to another app” (I10). However, in the future, “we want this to be a fully integrated solution with a range of MSPs” (I18). This is besides commercial barriers due to different readiness levels and integration efforts.

In this context, I10 recognises that “there are mixed readiness levels. Some are ready and can do it tomorrow; some are six months, maybe longer, to go away” (I10). I10 sees “a bit of a split between what we call legacy public transport providers and the new mobility providers” (I10). One crucial factor is that when they want to be part of the solution, “they need to have resources for that” (I10). The traditional roles of transport operators have also caused this skill and knowledge gap. For this reason, CS5 is “not just looking to buy MaaS technology, but a partner who can do the integration for us as well” (I15). However, the plan is “to technically understand how we can help them get through this complexity to integrate into MaaS” (I18). In terms of prioritisation, CS5 approached this topic by thinking about the critical mass needed to establish MaaS, “we have one bus operator that runs over 90% of the bus services […], if we don’t have them on board, that’s a big element of the transport system that we’ll miss” (I18). This has also been learned from the conducted pilots “that we need a product with almost everything we need or that the users need” (I10). The strategy has been to use aggregators, “integrating every single one is probably a big piece of work and maybe not worth all our time” (I10). This goes hand in hand with the mentioned prioritisation done by selecting the ones which “will hit our aims and goals in terms of integration” (I10).

Mobilisation (Activities and Evolvement of the Network)

Mobilisation is already happening for CS5 in different aspects. For example, through the deregulated markets, the environment can be seen as “totally competitive” (I15). For this, the aim is to go to a “the (country) government is going to change the market for buses into a franchised approach, so we are mobilising to take control of the bus network” (I15). As a result, the network is evolving regarding leadership and vision.

Previously, “we don’t really have someone championing or expanding shared mobility in (CS5)” (I15). However, not being an advocate of MaaS, the path to further development is blocked. I18 expresses this through a MaaS champion “we have a couple of key champions, within the authority, the politics, and senior leadership side, who are very supportive of the concept of MaaS and have helped to bring other stakeholders along that journey and convince them that this is the right things for us to be doing” (I18). According to I10 if a MaaS provider is willing to come on that journey and be flexible “comes back to behaviours and culture” (I10). Being part of the digital tech worlds, the transport worlds and networks are “being brought much closer together by things like MaaS solutions” (I10). As a result of that, a “culture change” (I10) and constant evolvement of skills are required. That creates in this evolving network skill and knowledge challenges as “a public sector authority isn’t used to having those roles” (I18). For these reasons most of the public MaaS providers rely on “consultants to deliver some of that for them” (I18). However, it is clear that in future “they should do it in-house […] and develop the relationships internally rather than paying consultants to do it for them” (I18). The challenge here is also a funding challenge, but more embedding this into their “business-as-usual operation […] and integrate that into their day-to-day work” (I18). This requires going further than just the digital element of MaaS, it needs “to become a company-wide movement” (I15). On the other side of the evolving network are the users and getting them to adopt the solution: “how do you get people to adopt MaaS as a whole?” (I16). Here already a lot of work was done by CS5 to engage “with potential end-user and customer to understand pain points and journeys today where MaaS could help to tackle some of those issues” (I18).

One key has been to engage more with so-called trip attractors. Here, CS5 is creating partnerships with large employers, events, sports arenas, and concert halls "to partner with them to get them to promote MaaS to people travelling to their site" (I18). This has been a win-win situation for both actors as they can find ways to reduce "their carbon emissions associated with travel […], and it's good for us from a public policy perspective" (I18).

Key Barriers, Strategies, Learnings and Future Vision

There are multiple key barriers experienced in CS5. For I10, one of the main barriers has been prioritisation "lots of projects are going on, and so sometimes we see conflicts" (I10). Another barrier has been a technical barrier, "will the MaaS provider have to wait for an incumbent provider to develop a specific API?" (I10). For example, I10 also mentioned that persuading one of their MSPs to "transition from their existing product was a challenge" (I10). To gain trust, the strategy has been "to develop the product and come back with a fuller offer and proposal" (I10). Another key challenge is a social and policy one "there are certain stakeholders in (CS5) and within the transport community that don't think we should have our own app and we should just let the commercial sector lead" (I15). I16 describes the most significant barrier as ticketing and being "mindful of the inclusion agenda so that when people gets deployed, we don't digitally exclude other people" (I16). For I18, the biggest issue has been a social one "get senior decision-makers, politicians, commercial teams, IT finance and legal teams to understand MaaS, to approve it and buy into it" (I18).

These barriers are being addressed with different strategies, resulting in different learnings and best practices. For example, regarding fairness and inclusion, CS5 made "clear with the operators that we will be fair on the competition point" (I18).

For I16 focusing on token-less ticketing and reducing barriers to accessing mobility services would also help. This goes hand in hand with a “bus reform […], having something modern, digital and easy to use for the bus offers” (I16), with a minimum digital rule of play. Another strategy has been to form a consortium that is a “meet-up of 14 different cities around the UK exploiting regions exploring MaaS […], we run this meet-up to exchange ideas” (I15). These barriers are used for feedback for the government, “we fed into the government’s code of practice for MaaS consultation earlier this year and were collecting more information that we will send to the government on areas where we have seen challenges that we think policy or regulation could help develop” (I18). I15 highlights a piece of legislation called the “well-being of future generations act […], which is a piece of social legislation that ensures that we do our best for the next generation of people” (I15). Thus, the best practice would be to frame policy, regulation, and technical standards which are “co-developed between the public sector and the private sector” (I18).

Considering the future, I10 sees the need to have certified MaaS providers “because there are too many MaaS solutions” (I10). This future vision for I10 is to “get to a place where what we’re offering in terms of incentives, in terms of modal recommendations, whatever it is that is personalised and tailored to the user” (I10). However, this requires a mindset change. Further, I10 expresses that MaaS can be linked in the future in the context of city planning to “residential planning and new developments” (I10). This view is shared by I15, who thinks it can help to understand “where the gaps are in the transport market, and then we can look at orchestrating the transport network” (I15). For example, if an event occurs in the region, mobility can be redistributed by bringing “another bus from over there” (I15).

Besides that, there will be an automated mobility settlement “we don’t want people to buy a ticket, we want people to trust they’re going to get the best value fare and the convenience of tapping on and off” (I15). However, I15 agrees this “will need complex commercial agreements to put that in place” (I15). Here, I16 and I18 emphasise that the future battleground will be to create a level playing field and to define fair and inclusive “regulation and algorithms” (I15). If this is done right, I15 sees that “the real potential of a perfect MaaS solution […], proves MaaS to the region and the city, not necessarily to the individual” (I15). Here, the platform needs to take “a modular approach to building the MaaS platform […], what I mean by that is breaking down some of the key bits into the component by heart so they can be switched out and done differently” (I16). As a result, MaaS could enable in future “new products and services for customers that can be made available through MaaS or otherwise” (I18). Regarding future ownership, MaaS will likely be a publicly led model but “delivered with a private sector partner. Moreover, we think that what that does, it draws on the best bits of the public and the private sector” (I18). Thus, new brands will be established, and the “MSPs will move closer with public providers and deliver this” (I18). Here it is likely that in the micro-mobility market, there will be a consolation happening. This leads to increased interoperability, and in this context, MaaS roaming is described as one important factor in the future “we do have to think about how it (CS5) stitches up” (I10).

CS5 Summary including the Actor Network

Table 17. Summary of Individual Themes of CS5

Themes	***Key Observations and Insights***
Problematisation	➢ Goal is to integrate collaborative MaaS for the region. ➢ Existing apps will be replaced; the first pilots happened. ➢ Public-private partnerships and inclusive MaaS business ecosystem.
Interessement	➢ Strategy has been to map out the MaaS business ecosystem. ➢ Some potential actors have been sceptical; to overcome this, they were included in the whole process. ➢ Procurement process the for digital service provider.
Enrolment	➢ Establishing the commercial model has been a barrier. ➢ Started with deep links, now moving to deep integration. ➢ Skills and knowledge gaps are experienced.
Mobilisation	➢ Competitive environment needs MaaS advocates and champions. ➢ Culture and behavioural changes are being triggered. ➢ Engaging with so-called trip attractors and dealing with the adoption of the network.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Barriers in all dimensions have been experienced. ➢ Social inclusion agenda in combination with the commercial model and change management. ➢ Strategy: Clarify that fairness and inclusiveness are important factors by creating a consortium. Framing policies, regulations and technical standards.
Learnings and Future Vision	➢ MaaS needs to be personalised and tailored to the user. ➢ Mindset change needs to be supported by initiatives. ➢ MaaS needs to provide a level playing field and complex commercial agreements with fair and inclusive regulation and algorithms.

Figure 23 depicts the actor network of CS5. The digital service provider has been a commercial company, multiple MSPs (both public and private) are involved, and the project has been funded through the Future Transport Zones investment fund.

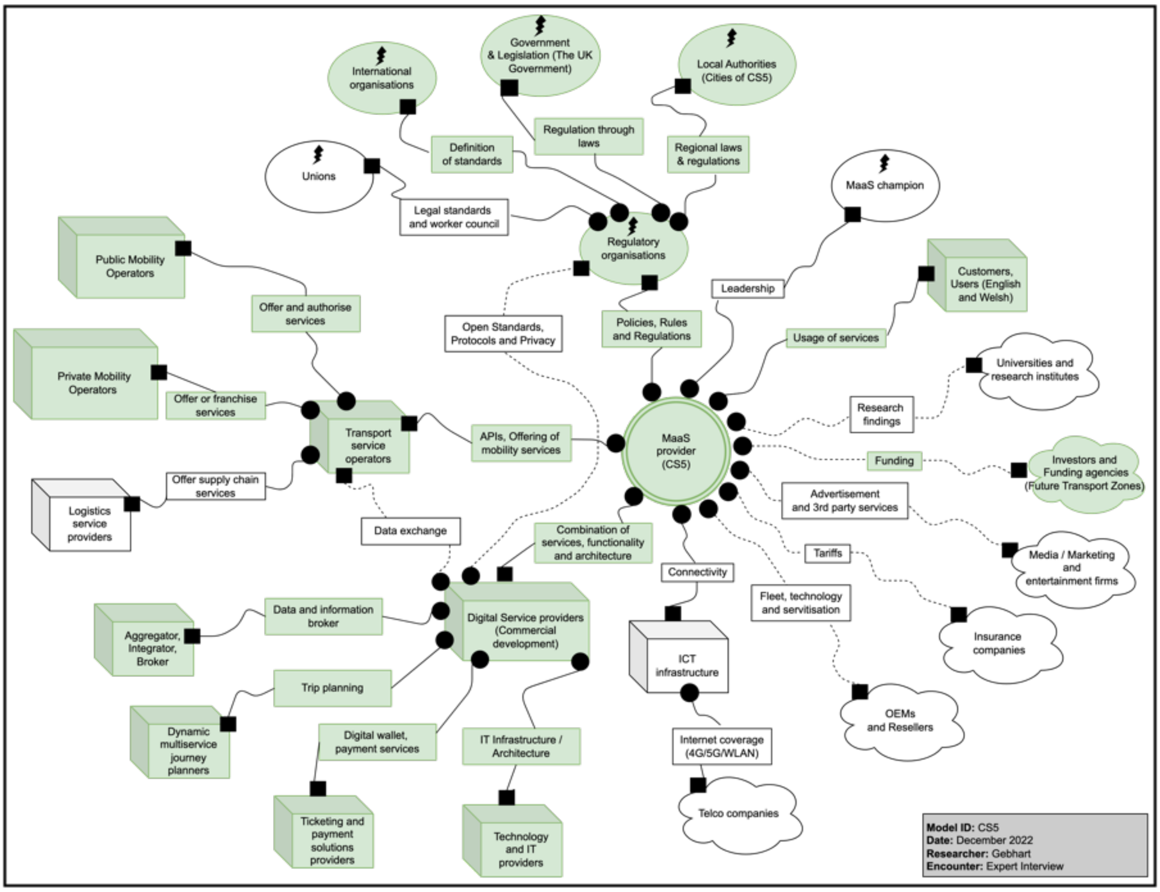


Figure 23. MaaS Business Ecosystem Actor Network CS5

5.1.6 Case Study 6: A Dutch Multi-City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS6 has been conducted with I13. CS6 started with "a focus just on the Netherlands" (I13), integrating preferably transport operators who are operating nationwide. Here CS6 already did MaaS pilots in the Netherlands and recently expanded on an international scale. Funding plays for CS6 an essential role as they operate in public-private partnerships. Being the MaaS provider of CS6, "we have a public role, but we can only support that public role if we get funded for that specific part" (I13). Here the goal of CS6 is to support the "societal goals involved concerning the availability of such a service in a local region" (I13). In this context, I13 defines MaaS from the end-user perspective "it is about providing you as a traveller all the direct access to all mobility options you have, including that of your own vehicle, of your own bike, and what else you have […], giving you access to the best suitable, sustainable, affordable solutions for you to get from A to B" (I13). Further I13 argues that "it is not making it a subscription model where you have an all-you-can-eat service for all kinds of public transport and perhaps micro-mobility" (I13). Thus, MaaS is "about the customer, and I specifically don't say the end customer because it all starts with the customer. It doesn't end there" (I13). This can be seen as a precious definition pointing out that the ecosystem is essential as well. According to I13, the "ecosystem is about all the companies and the government, your employer, perhaps even the location where you live, and your housing regulations" (I13). This is a very user-specific definition but includes all commercial and government parties as well around it "working together to change travel behaviour" (I13). This cooperation is required in a public partnership, making sure that "not just all work independently" (I13).

Interessement (Case Approach)

For CS6 finding other actors has been “not the hardest part” (I13). Getting them interested included reviewing and asking about the commercial, technical and policy perspectives: “Is it commercially interesting? […] How ready are their API? […] Do they already have agreements in place?” (I13). CS6 tends to sign those agreements internationally because, without any additional agreements, they can expand CS6 to other cities. For this, “all new agreements we sign with parties are international” (I13). With this, CS6 can expand to other cities without signing additional agreements. Further, I13 highlights that CS6 is also prominent, which is why “we also attract them” (I13).

Enrolment (Actor Integration and Onboarding)

I13 points out “that the integration is looked upon very differently in different countries. In the Netherlands, we see it as a commercial, as a purely private undertaking, where there should also be competition between market parties reaching the customer” (I13). This is different to other countries where this is instead a public authority effort. Here CS6 started with nationwide services and now “we are looking for smaller, more localised parties” (I13). For prioritisation and integration, the three things are important. The first one is scale, “how large is their operation fee and international availability?” (I13). The second one is concerning their interfaces. Here it is essential for CS6 “if they are using a standard API to do the integration” (I13). Most of the time CS6 will use the standard interface of the actors “if they are large” (I13), if they are small CS6 uses their standard interface and helps to the actor to develop such an interface. The third point is external funding; the integration strategy changes depending on how much money and resources are available. Most barriers arise in the integration process “there are a lot of technical issues” (I13).

For example, there are companies “that existed already for 30 years and are now confront with a MaaS market, […] they don’t have the investment ready, […] it would need a complete overhaul of their whole backend” (I13). Other technical issues were caused by the “type of connection” (I13). Because of these technical issues, CS6 started “with deep links to other apps, and now know that doesn’t convert the customer” (I13) because they found out that deep links are not generating extra value. Finally, the “service level support; how do we handle support from the customer?” (I13) plays an essential role in the onboarding process of new actors.

Mobilisation (Activities and Evolvement of the Network)

Regarding mobilisation, I13 emphasises that essential activities in the evolvement of the network are to get the users' acceptance, change their travel behaviours and minimise their lack of trust: “we have never been able with a MaaS service on your smartphone that changes people’s travel behaviour on such a scale that it’s becoming commercially interesting for everybody to start working on it. […] We need to show it works” (I13). Otherwise, the network cannot evolve because “we can never convince any policy maker, any city, or transport service operators themselves with a proper business case” (I13). However, this is also “a bit of a chicken and egg problem” (I13).

Key Barriers, Strategies, Learnings and Future Vision

Regarding the key barriers, I13 describes commercial barriers, "at this moment, we cannot commercially do any loyalty program because the transport operators don't provide such a loyalty program for us, because they want to have their own loyal customers" (I13). However, CS6 "can't change the regulations for public transport operators" (I13), but their strategy has been "to prove that we also have some extra value for them. We keep discussing; we keep talking to them" (I13).

Concerning key learnings for the future, I13 advises that “cities everywhere in Europe need to have an obligation for each transport operator to have a minimum API for such a full integration available” (I13). In terms of integration, I13 concludes that it makes sense to “integrate nationwide, perhaps even on a European scale […], but target the travellers local or regional” (I13). The local public authorities should work with “international providers certified to work with a region” (I13). Certified in that context means that the city offers a license to operate in this city. This goes hand in hand with the “obligation to have an integration with one or more MaaS providers” (I13). This concept of being a certified MaaS provider can then be a “model that could be applicable also in other countries” (I13). Further, I13 advice that "the commercial agreement should be very easy […], have a template for the agreement" (I13). In terms of funding and to trigger social change, I13 sees the responsibility in the government. The government should say "here's a fund; there's a consortium, you can apply to that consortium. Then there's a consortium for each city, and MaaS providers could apply for those cities and then maybe develop and streamline that development" (I13). In terms of the future, CS6 sees the B2B space with mobility budgets as interesting, "we now are looking for or integrating our service into the employment conditions for a number of employees in the Netherlands" (I13). In addition, I13 sees that MaaS can be used as a control instrument for the city to reach societal goals, "all the certified MaaS providers can easily participate with certain incentive program from a city. Each city can do it differently because they all have their own goals" (I13). In this context, the city should "allow all the market parties to participate" (I13). At its core, the future needs to be "a nationwide service" (I13), that is fair and inclusive for both the MSPs and the clients. CS6 and MaaS, in general, should be a public asset, creating a "level playing field" (I13).

CS6 Summary including the Actor Network

Table 18. Summary of Individual Themes of CS6

Themes	***Key Observations and Insights***
Problematisation	➢ MaaS pilots in the Netherlands and then expanded. ➢ Goal: to support societal goals of the local region. ➢ CS6 is a public-private partnership, and the ecosystem is seen as cooperative, including companies and the government.
Interessement	➢ Has a commercial, technical and policy perspective. ➢ The strategy to get them interested is to make CS6 a prominent example. ➢ It is tried to make agreements international.
Enrolment	➢ Integration is purely commercial in the Netherlands. ➢ Scale, standard interfaces and funding are important factors for prioritising the enrolment. ➢ Technical barriers exist, and deep integration is aimed for.
Mobilisation	➢ Acceptance of users is crucial, and it is essential to demonstrate CS6 works. ➢ The barrier is to convince any policymaker or city with a proper business case. ➢ Chicken and the egg.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Commercial barriers: Loyalty programs are hard. ➢ Strategy: Actions prove that it is valuable for them. ➢ There should be an obligation for each transport operator to have a minimum API available.
Learnings and Future Vision	➢ Integrate nationwide but target users locally or regionally. ➢ The idea of certified MaaS providers. ➢ Templates for the commercial agreements. ➢ Government should drive and fund initiatives. ➢ The future should be fair and open, creating a level playing field.

Figure 24 depicts the actor network of CS6. The digital service provider has been a commercial company, multiple MSPs (both public and private) are involved, and the project has been funded through different investments and cities in the Netherlands.

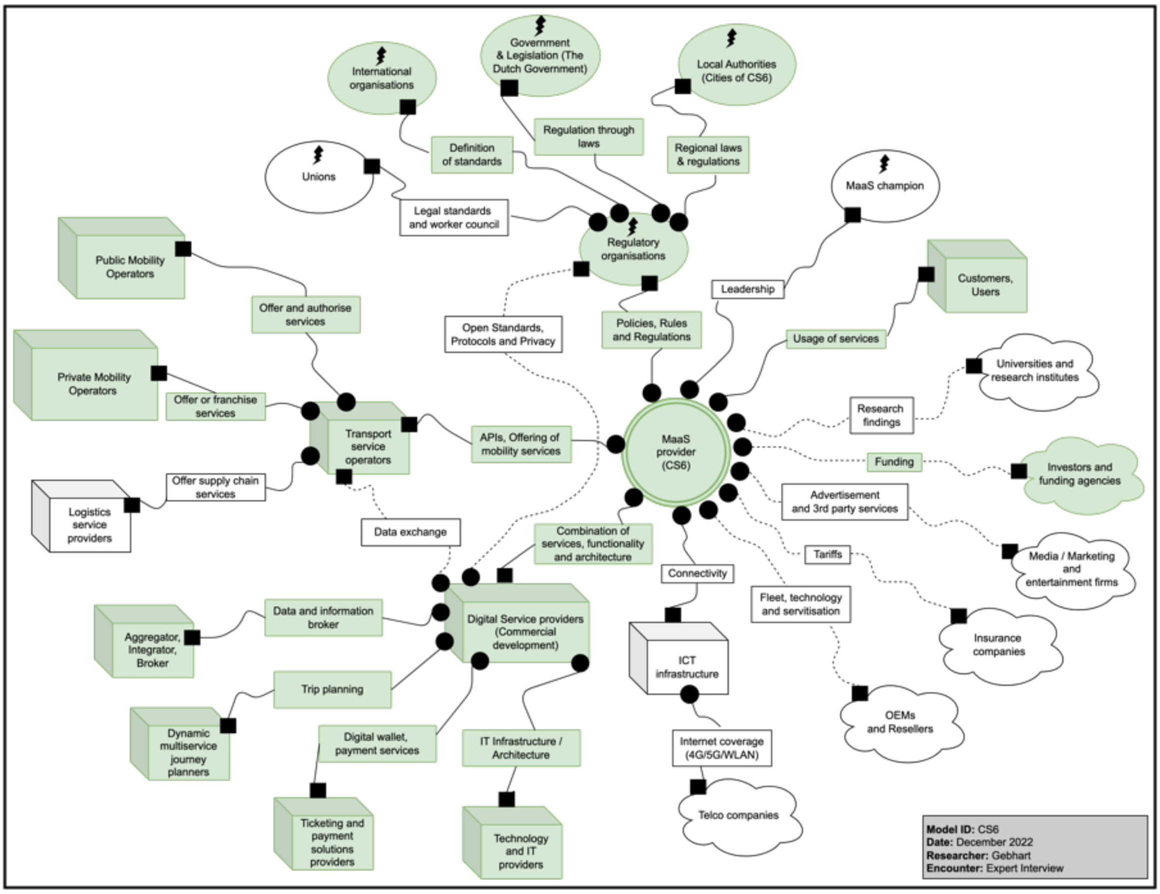


Figure 24. MaaS Business Ecosystem Actor Network CS6

5.1.7 Case Study 7: A Czech City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS7 has been conducted on a Czech city MaaS platform with I14. The MaaS idea started in the city and was realised in “three parts: a public transport application, a mobility app, and an intermodal router planner” (I14). According to I14, the “plan was to create these systems together, but our inner political decisions made it split” (I14). Currently, these systems are developed apart from each other using their development capabilities. The reason for developing it with their capabilities is that “we keep them in our hands so we can operate; we can handle it; we can change it; we can update it. So that’s the reason why we are developing and don’t buy it from the commercial sphere like other cities” (I14). Compared to other cases, that is a unique approach. CS7 is developed through a city-owned company and funded by the city. I14 highlighted “we had to defend it in front of the city council, and they gave us the mandate to realise the project […], this includes the development of the system, the integration, the initial operating phase and the future operating phase” (I14). The goal as a city company to create this system has been the endeavour “to operate this system; we’d like to create it because we can keep equality between all providers and us. The city is motivated to support these public mobility providers because it is a more sustainable means of transport or a more sustainable system for travelling and commuting in huge cities” (I14). In this context, MaaS and its business ecosystem is defined as “everything should be integrated and shared in one app […]. I’d like to have one registration and use all of it” (I14). In terms of the ecosystem, I14 states that “we have the public transport ecosystem […]. On the other hand, there is a second ecosystem, and it’s the shared mobility ecosystem. Currently, both parts have started to work together” (I14).

This demonstrates that MaaS enables to merge the existing ecosystem into one combined ecosystem. According to I14, CS7 “is the best way to encourage this more sustainable travelling with a MaaS app and a combined MaaS ecosystem” (I14).

Interessement (Case Approach)

The interessement process for CS7 has an internal and an external facet. First, “the process of defining the project takes a lot of steps” (I14). That means that internal stakeholders and departments had to be interested in CS7 and needed to be persuaded. As part of the “business case, we analysed the existing mobility providers interested in these projects” (I14). For this, I14 had to “introduce them to the project and ask them if they were interested in being part of it” (I14). This approach has not been straightforward. According to I14, “they will see us like they don’t need us” (I14) because they are quite successfully operating in the city without being part of CS7. In addition, I14 states that it was “hard to get in touch with them” (I14). This is also caused by power relationships and the fear of losing control and influence “they see how strong they are now, and they sometimes don’t want to be part of (CS7)” (I14). Also, they might be afraid to “lose some data because we can provide everything” (I14). However, the strategy of I14 has been to show them “the potential for rising profits and right” (I14). An important factor when getting other actors interested is the critical mass: “the MaaS solution can only work if there are all providers, so we can’t have only half of them” (I14). So, in terms of interessement strategies, “we’d like to cover as much as possible, and all means of transport” (I14).

Enrolment (Actor Integration and Onboarding)

Regarding integrating new actors, I14 agrees that “full integration is the best way” (I14). However, I14 sees multiple barriers.

One barrier is integration efforts: “integration is hard. It will cost a lot of money and time and they sometimes don’t see the profits, but we see the profits” (I14). Further, I14 demands better governance frameworks, policies, and regulations to simplify the integration of different actors. Here, “our regulations or laws can’t allow the city to say you can’t operate here” (I14). Being able to control the mobility ecosystem and actively design the city's urban space is an essential factor here. Because of the maturity and size of some local players, manual processes are not yet digitised, which is a barrier for the enrolment, “the small car-sharing companies have a very simple mobility app. They have employees who sit there and check their faces and ID” (I14). In this context, the lack of openness of data and standardisation also plays a role: “Integrating all public providers is tough. Every provider has a unique system; they have their own requirements and so on. And now, we are facing the most critical phase of the project, and it is to create a business model” (I14).

Mobilisation (Activities and Evolvement of the Network)

The development of CS7 is still in an early stage. Mobilisation of the network did not happen at this stage.

Key Barriers, Strategies, Learnings and Future Vision

The key barrier observed by I14 “is the business model, because for the technical challenges; we can handle them” (I14). This goes hand in hand with the commercial model because with every provider, “we must create an individual condition of co-operation, […] we must find a solution which covers all those requirements for each provider” (I14). The strategy applied here by I14 is prioritisation because otherwise, “it will be crazy for us to handle all requirements” (I14).

One learning derived from that has been to start small learn and then scale “we start with a MSP, which is already integrated somewhere, so we can learn a lot and then we use this approach for another MSP” (I14). Further, I14 indicated that best practices from other cities would be beneficial “it is very helpful to speak with other cities […], I would appreciate if there would be some analysis, of what the best approach would be […], I see potential in your work and in your system” (I14). This shows that the research is very needed and valuable for the practitioners. Considering the future, I14 wants to stay the solution owner and develop it with its capabilities, being a neutral provider: “as a city company we’d like to operate this system; we’d like to create it because we can keep equality between all providers and us” (I14). This also shows that the future of CS7 will be inclusive and fair. Also, I14 highlights that inclusivity extends to having an affordable price offered in the platform “the service are still a bit expensive. […] I’d like to have more, not cheaper, but affordable service for the citizens of CS7” (I14). In this context also, MaaS roaming is mentioned: “I hope that our system will share services with another big city in Czech Republic” (I14).

CS7 Summary including the Actor Network

Table 19. Summary of Individual Themes of CS7

Themes	***Key Observations and Insights***
Problematisation	➢ Development of different components and apps. ➢ Own customised development for more sustainable travelling. ➢ City-owned company.
Interessement	➢ Internal and external facete. ➢ Many barriers observed. ➢ Critical mass is the goal.

Enrolment	➢ The goal is full integration (LVL3). ➢ Barriers regarding regulation and technical readiness are observed.
Mobilisation	➢ CS7 is at an early stage, mobilisation did not happen.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Creation of a business model in combination with the commercial model. ➢ Prioritisation strategy was applied.
Learnings and Future Vision	➢ Start small, learn and then scale. ➢ Fairness and inclusion: make the platform and services affordable.

Figure 25 depicts the actor network of CS7. The digital service provider is CS7 itself, multiple MSPs (both public and private) are involved, and the project has been funded through the city council of CS7.

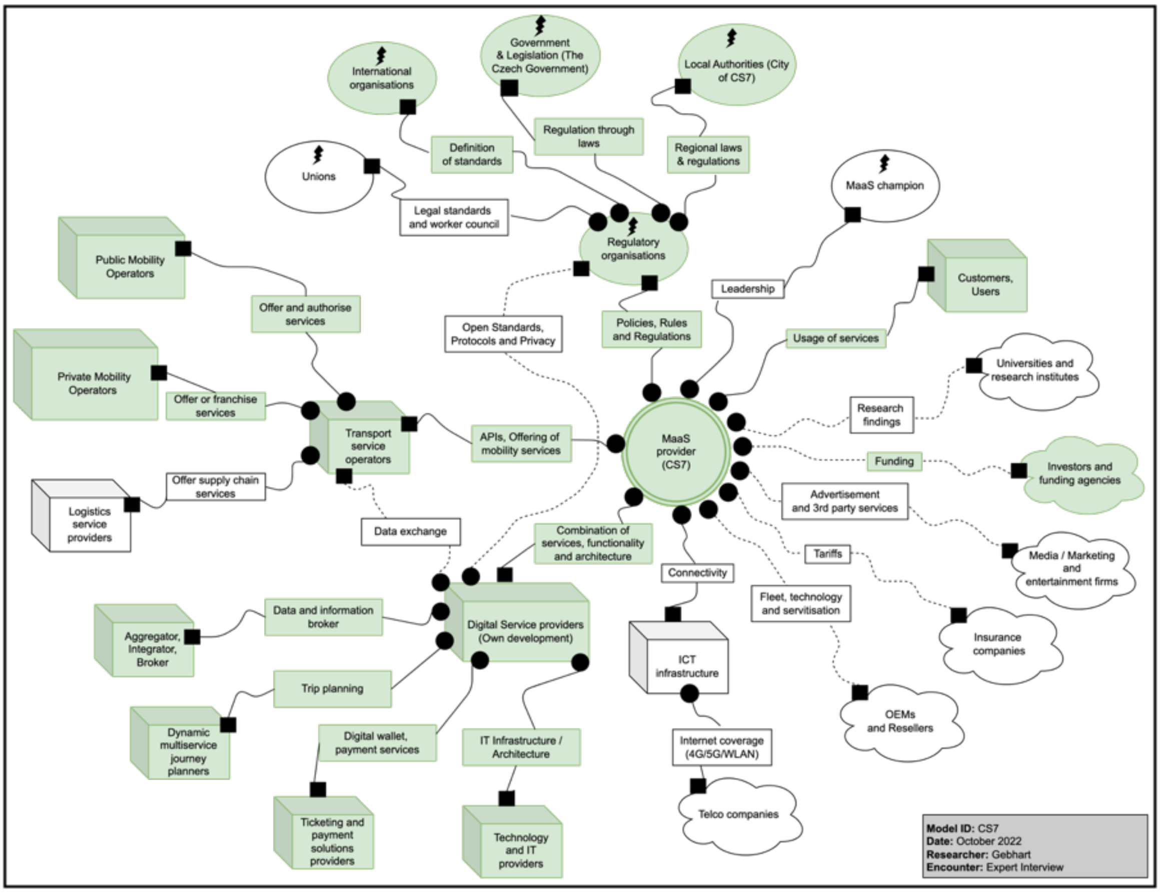


Figure 25. MaaS Business Ecosystem Actor Network CS7

5.1.8 Case Study 8: A Lithuanian City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS8 has been one of the first MaaS city implementations. The interview was conducted with I6. The city observed at that time that “there were some apps that were launched for city services like parking and transit systems” (I6). However, at the same time, I6 recognised that the “city doesn’t own most of them, so we should promote companies that are already building and planning applications to integrate our APIs and our services to create a platform” (I6). The idea was to consolidate all mobility providers into one app. The target audience for this app is people “who have short trips during the day, so they could plan them with (CS8) and change their personal vehicles of transportation into something that is more sustainable” (I6). I6 said these were “young professionals, office workers, and people who move around a lot” (I6). Further, CS8 addressed new multi-modal opportunities that were possible at this time: “for those who think they know it all right, because sometimes you need to check again. Some years go by, traffic changes and your common bus is not necessarily the best option anymore” (I6). In this context, I6 defined MaaS and its ecosystem from the point of the citizen. It helps you “to get from a place A to B, with having the bigger picture view” (I6). The ecosystem is about the services provided, and the user does not care which provider is behind the service.

Interessement (Case Approach)

Back then, the city's ecosystem already included four types of public transit: car-sharing, taxi or ridesharing and two different car-sharing providers. That means that many providers were there which could be interested and integrated into CS8. Regarding getting the actors interested in CS8, I6 stated that this was not an extensive analysis because you “just know everybody” (I6).

However, it was needed “to tear down some borders between the institutions and the businesses” (I6). To address this, the municipality formed “some sort of a committee or a board where we just gather with MSPs to discuss ideas” (I6). This has been necessary because public and private mobility providers have seen themselves as competitors, “they are competing for the schedule” (I6). In this board, the general conversation had been to present the project and its benefits. However, I6 stated that “we should have made this into a more formal process” (I6). Nevertheless, the board was formed to foster collaboration and cooperation between the actors involved to tear down barriers. This helped to make them interested in joining CS8.

Enrolment (Actor Integration and Onboarding)

Regarding enrolling new actors, CS8 worked with a digital service provider founded during this project. The work with CS8 had been the testbed for the digital service provider. Here CS8 could, first of all, reach a conclusion with a mobility provider “we agree with them to do such and such” (I6) and then CS8 could hand them over to the digital service provider “they discuss it, and their technical people discuss it” (I6). The focus of CS8 is then “to focus on the bigger picture and the high-level decision” (I6). Most actors have “had a very specific interest in why they want to cooperate” (I6) because the city with CS8 subsidises the cost and sets regulations. The mobility operators wanted “to have a good relationship with the city” (I6). In terms of integration, different levels of integration existed with the partners. Because of high integration efforts for some providers, CS8 just “showed the availability, and you would then be transferred into their own app, and you can pay there” (I6). However, for most actors, “full integration was reached” (I6).

Here, I6 suggested starting small and then continuing with scaling the solution "do a sort of a pilot project, see if it works, and you know if you have different providers […], when you have the critical mass of mobility providers then others will definitely want to be part of it" (I6).

Mobilisation (Activities and Evolvement of the Network)

A mobilisation was observed in the network because a critical mass was reached that made other mobility providers interested in joining, and it was attractive to the citizens of CS8. Further, to prevent competition or losing control and influence, CS8 "enacted some sort of a committee or a board where we just gather with the MSPs and discuss ideas" (I6). From this committee, most of them learned that they are not competing but can better "target the audience that is travelling by car" (I6). On the customer side, CS8 had a reasonable adaption rate. However, "there were some sentiments that we should focus more on the heavy-duty stuff like modernising buses and infrastructure" (I6). Also, with CS8, a mindset change could be triggered. However, considering the multi-modality reality, I6 thinks this "is still some part of the future" (I6).

Key Barriers, Strategies, Learnings and Future Vision

In terms of the key barriers, I6 did not experience showstoppers. Nevertheless, when problems emerged, "we somehow involved higher officials" (I6). This action-based problem-solving approach used "exerting higher level influence" (I6). The involvement and acceptance of the leadership of CS8 helped to champion these barriers. However, regarding a governance framework for MaaS, "we definitely were looking for some sort of regulation that could be used" (I6).

According to I6, it would have been great if the city “could have the authority to decide that all the mobility solutions should be registered and there integrated into the system […], but there was no framework and no authority delegated to the local government to enact such regulations” (I6). Having such an onboarding process in the city would be very beneficial for CS8. Regarding other learnings and success factors, CS8 had been lucky, as the digital service provider used CS8 as a “sandbox for their product” (I6). Also, I6 states that “we had a good ecosystem of mobility providers that just started there, and we had a liberal mayor that had invited business to create and innovate” (I6). This comes back to having a MaaS champion both on the policy and the technical side. The future of CS8 is seen as fair and inclusive, being “overseen by some sort of government agency, but definitely run by a private operator” (I6). This should be executed as a public-private solution: “there should be some sort of symbiosis between the public and private operators” (I6). Further, I6 sees modularity becoming increasingly important “maybe (CS8) should involve more solutions based on specific user needs” (I6). Here CS8 should be more personalised and “tailored to the users’ needs so that the user is not pushed into the direction of public mobility but would feel that the user has some sort of a mobility partner to user for his everyday needs” (I6).

CS8 Summary including the Actor Network

Table 20. Summary of Individual Themes of CS8

Themes	*Key Observations and Insights*
Problematisation	➢ One of the first MaaS solutions. ➢ Started with a specific target audience. ➢ Helping citizens to better get from place A to B.
Interessement	➢ Cooperated with a digital service provider. ➢ Everybody knew each other in the city. ➢ Board was created to discuss ideas and get actors interested.
Enrolment	➢ Technical enrolment happened through the digital service provider. ➢ Deep integration was aimed for. ➢ Critical mass has been reached.
Mobilisation	➢ First committee and board meetings established. ➢ Mindset change for MSPs and citizens has been triggered.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Missing regulative frameworks and best practices. ➢ Action-based problem-solving by exerting a higher level influence. ➢ Authority for the city would be needed with a straightforward onboarding process.
Learnings and Future Vision	➢ Having a MaaS champion both technical and political, is very useful. ➢ Future will be fair and inclusive, run by a government agency but operated by a private operator. ➢ More personalisation is needed to trigger mindset change.

Figure 26 depicts the actor network of CS8. CS8 has been developed together with a digital service provider. Concerning the actor network, the digital service provider is a commercial service provider, multiple MSPs (both public and private) are involved, and the project has been funded through the city council of CS8.

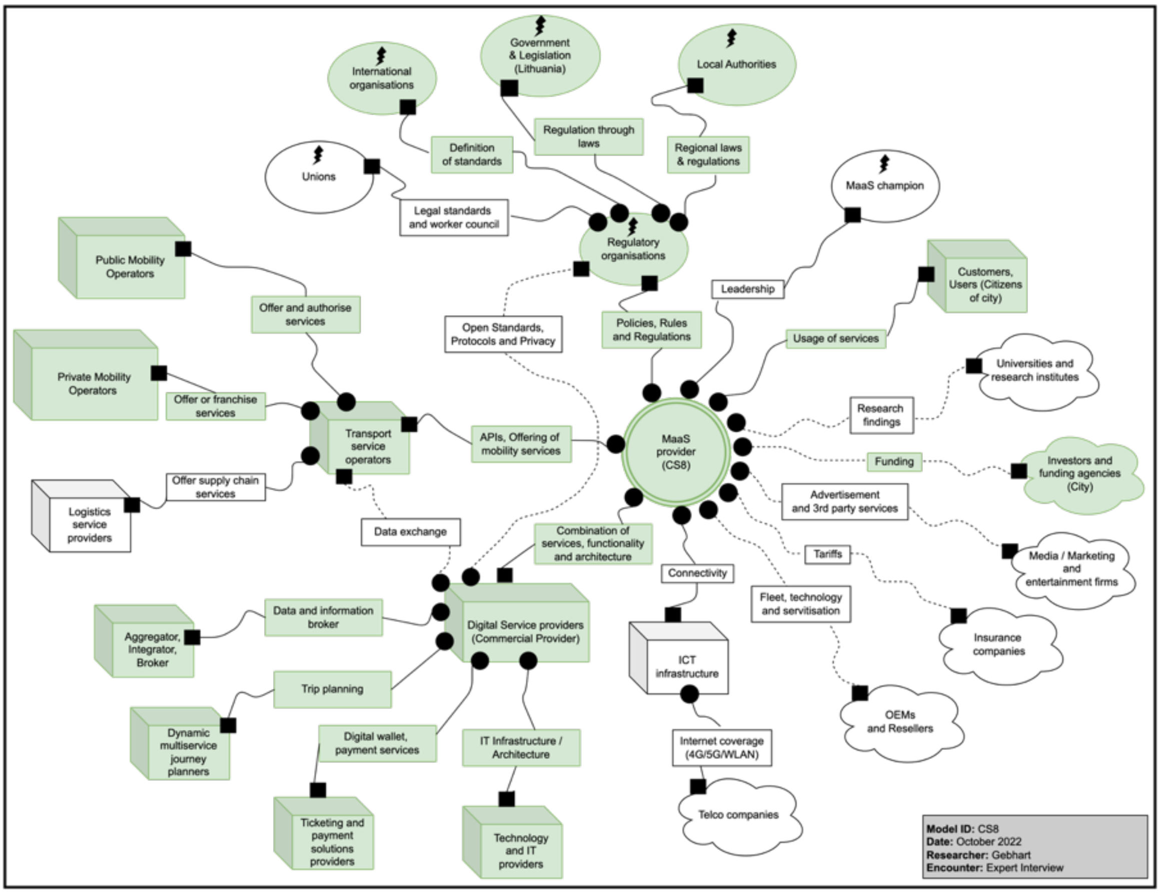


Figure 26. MaaS Business Ecosystem Actor Network CS8

5.1.9 Case Study 9: A Hungarian City MaaS Platform

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

CS9 has been conducted with I11. The goal of CS9 has been “to convince people to change to public transport” (I11), as the city of CS9 is facing severe traffic issues. CS9 started based on three existing apps. One app is “about journey planning” (I11), the second one displays “actual information about public transport” (I11), and the third one has been “digital ticketing” (I11). However, after three years, some apps' support stopped, and a new solution was needed. At the same time, the city faced “budget problems because of Covid” (I11). According to I11, the question was, “with a moderate budget, what could we develop?” (I11). The focus of CS9 has been on mobile applications, and based on this, “we introduced a new application with (CS9)” (I11). Regarding the definition and the solution of CS9, the solution should “apply to every means of transport” (I11). In terms of the ecosystem, I11 includes public transport, “the classic ones like buses and trams and undergrounds” (I11) and “all the micro-mobility players” (I11).

Interessement (Case Approach)

Getting other actors interested and “getting in contact it’s not difficult” (I11). I11 states that “we know almost all companies and we do have contacts” (I11). With the new solutions, CS9 had discussions with all relevant actors. Based on these, it was then decided with which actors to start. In detail, the prioritisation of different actors was decided based on technological, commercial, and social factors: it was based on “technical and commercial issues and the potential impact” (I11). First has been the technological question, “what is their API? How difficult is it to introduce from an IT perspective?” (I11). The second step was to examine the commercial issues regarding contractual issues, costs, and time planning.

Here, CS9 performed a cost-benefit analysis by looking at the business case. Then in the third step, it was looked at the potential impact the new actor could bring and regulatory questions. For example, I11 asked interested actors, “how many people are using it (your solution)? […] and for what kind of reasons?” (I11). With this process, CS9 also ensured that their potential partner actor is fluid in terms of money and market size because there is high volatility existing in the market. Also, their users trust CS9, and they wanted to ensure that they can also “trust better these companies” (I11).

Enrolment (Actor Integration and Onboarding)

CS9 started enrolling actors with the Metro, and I11 stated that “we are now integrating the regional buses” (I11). After that, CS9 plans to integrate micro-mobility. The strategy for integrating micro-mobility in CS9 has been using aggregators, “we try to somehow do that more effectively and integrate one platform, that already includes six players” (I11). In terms of depth of integration, I11 favours a full integration. Here I11 sees three levels of integration, “the first one is like the point of showing information, […], number two, you can plan your journey […] and number three is they payment included” (I11). Barriers I11 observes in this context are integration efforts and liability: "booking and paying is tricky from a technical point, but even trickier from an operation point” (I11). This point emphasises the importance of liability because if something unexpected or fraudulent happens during booking and paying for a trip, the MSP or CS9 will be responsible. Another technical barrier in the enrolment process discussed by I11 is data accuracy. Some actors stated, “we didn’t have real-time data. And without real-time data, we didn’t want to introduce them” (I11).

This barrier also led to synchronisation issues caused by unclear or no platform architectures existing. For example, when one actor changed their interfaces, “it collapsed” (I11).

Mobilisation (Activities and Evolvement of the Network)

Regarding mobilisation, trust had to be established first because some actors feared “that their application won’t be used anymore” (I11). In addition, there are social factors in building the ecosystem because sometimes “it’s about egos and organisations […], even if it would be a win-win situation, they are saying no” (I11). Another critical aspect of evolving the network, for example, is mobile ticketing, “there is regulatory for that, and there is a Hungarian national mobile ticket provider […], but you have to pay five percent commission to them” (I11). This is why some MSPs do not want to sell tickets to CS9 “because they would have to pay five percent” (I11). However, first mobilisation activities are observed. Here I11 names, for example, that spokespersons exist and that there is an informal part. New actors are “calling each other, asking, how was the work with (CS9)?” (I11). This conversation also shows that the network is evolving. In terms of expanding the network, I11 says that because the city funds them, their focus will always be on the city and greater urban area of CS9.

Key Barriers, Strategies, Learnings and Future Vision

The key barrier has been in the technical space concerning integration effort, “to work a lot and test a lot” (I11). This barrier also goes back to the legal side and agreeing on the commercial construct, “you have to defend yourself and write a contract; I will provide this and this type of data and if there is a change; I will go with it and I will do my homework if it’s necessary” (I11). To address these barriers, CS9 adopted different strategies.

First, before a contract or commercial agreement was reached, a cost-benefit analysis was conducted. If there were any severe issues, focus group meetings were set up. Second, aggregators were used, if possible, instead of establishing integration with every single MSP. The relationship with CS9 being the public transport operator helps because the MSP wants “a good relationship with the regulator” (I11). Further, “everybody loves success stories” (I11), and communicating a successful project between an MSP and CS9 can be a win for both sides. Regarding the future of CS9, I11 sees it as a control instrument of the city for events. Different mobility options can be suggested depending on the size and type of the event. Also, city planning and development can be used to “focus on a specific part of the city and to identify if there are any parts of the city, which are not so well covered by public transport” (I11). Further, technical improvements are needed to become a true meta app for mobility, “everybody should be there […] and what’s important, that it is personalised” (I11). Finally, also the mobility settlement should be automated. I11 sees “the long term, smart and convenient ticketing” (I11) as necessary.

CS9 Summary including the Actor Network

Table 21. Summary of Individual Themes of CS9

Themes	***Key Observations and Insights***
Problematisation	➢ Goal has been to convince people to change to public transport. ➢ Three legacy apps were existing. ➢ Focus on mobile applications.
Interessement	➢ Most of the partners are known. ➢ Technical, commercial and impact as prioritisation criteria. ➢ Neutral position, building trust among partners.
Enrolment	➢ Started with PTOs, then moved to micro-mobility. ➢ Full integration favoured. ➢ Technical barriers faced.
Mobilisation	➢ Social and political awareness. ➢ Spokespersons help to champion CS9. ➢ Network evolves and there is an informal exchange amongst the actors.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Technical barriers in terms of efforts to integrate and commercial barriers. ➢ Strategies include cost-benefit analysis, integration of aggregators, focus group meetings and communication of success stories.
Learnings and Future Vision	➢ MaaS is seen as a control instrument for the city. ➢ MaaS can support urban planning. ➢ Automated mobility settlement and true meta app for mobility.

Figure 27 depicts the actor network of CS9. CS9 has been developed on their own. Concerning the actor network, multiple MSPs (both public and private) are involved, MaaS champions and the project has been funded through the city council of CS9.

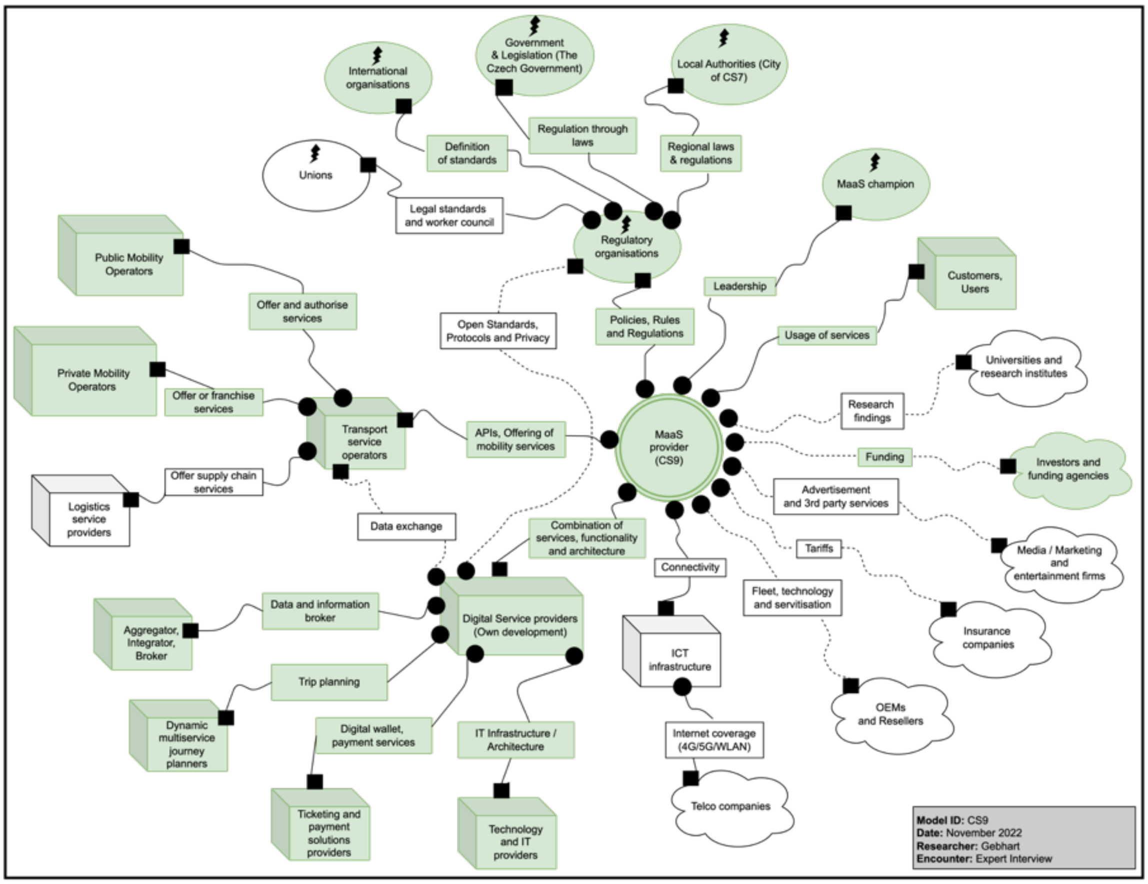


Figure 27. MaaS Business Ecosystem Actor Network CS9

5.1.10 Case Study +: Additional Experiences from MaaS SMEs

CS+ is a collection of additional experiences from interviewees who mostly have an outside-in view of the different MaaS business ecosystems evolving in Europe. These views include perspectives of a lawyer working on regulating and coordinating MaaS policies (I4), a MaaS consultant advising clients on MaaS (I7), a Chief Revenue Officer of a MaaS company (I8), a mobility director for a greater urban area in Southern Europe (I12) and a project officer working on public transport information by building a MaaS platform in the UK (I17). These outside-in perspectives help better understand the barriers experienced and introduce additional aspects to the presented cases.

Problematisation (MaaS Definition and Ecosystem Conceptual Understanding)

Regarding problematisation, I4 sees the regulation of multi-modal digital mobility services as necessary. This includes accessibility of data but also, at a national level, what kind of accessibility data the operators “should provide and how it should be shared to make it possible to create accessible travel chains” (I4). This became important for the government early on, “we have national law entered four years ago” (I4). From this legislative perspective, the definition of MaaS is a data-driven one, “everything related to mobility and mobility data, so how one can improve physical services with data or create new services” (I4). In this context, the ecosystem plays a vital role in legislation because “in the legislation, you have to define the roles and players somehow that you want to regulate” (I4). Because many actors are involved in the ecosystem, “we have to recognise the most important players that we need to define to enable the whole ecosystem to grow” (I4). In contrast to that, I7 as a consultant focuses more on the customer perspective.

I7 sets new impulses to implement the topics and defines MaaS as a multi-modal experience "in which a customer can find out in the simplest and least complex, personalised way possible how he or she can take the fastest route, or perhaps later the route that saves the most CO2" (I7). I8 sees building a mobility marketplace being important with a particular emphasis on rail making "the car less attractive by providing better alternatives" (I8). Here rail is considered as better alternative because "they have a good value proposition […], if more people used rail more often, there would be more revenue for rail with minimal marginal cost" (I8). This creates a huge marketplace and "value for the ecosystem of first and last-mile suppliers" (I8). Thus, for I8 MaaS is a mobility challenge in which "shared mobility services are underutilised and with the capacity to serve more customers" (I8). In terms of the ecosystem this mobility challenges needs to be addressed with "fast integrations of mobility suppliers" (I8) including a "strong-value proposition for the end customer" (I8). This is also understood by I12, mobility director of a large urban area companies need to "make it easier for us to deploy public MaaS" (I12). However, they "should accept that there are things we already have" (I12). The main goal and problem of I12 is to define strategies "to bring more people to the public transport system" (I12). I17 agrees and describes that in the region many operators are operating "trying to get compatibility of their systems" (I17). Creating an open and fast to integrate MaaS platform is "going to play a big role in enhancing social and economic inclusion, specifically in the rural areas" (I17).

Interessement (Views on Case Approaches)

Engaging actors from a legislative outside-in perspective involves preparing national law and legislation by defining, "policy questions and the questions on what the National Law is and how it is prepared, and what the kind of impacts are" (I4).

Here, the transport services act is the central law that regulates MaaS services. The general idea is that "operators are obliged to grant access to ticketing and payment interfaces under that act" (I4). This law also is valid for the MaaS platform providers. That means if a MaaS platform offers services, for example, somewhere in Finland, they are obliged to grant access, "so it is working for both sides" (I4). In addition, payment is covered by other laws and legislation. I7 highlights that when advising clients on MaaS, carefully review existing transport planning apps to ensure they are "not cannibalising my own offering here" (I7). This fact could also generate competition and hinder new actors from being interested in joining the platform. For I7, it is essential to show "that you are not creating your own competition, but simply opening up the possibility of using another distribution channel" (I7). I12, for example, created a working group "to talk about the contracts and the way how the relationships should be" (I12). In this group, it has been vital "to make them feel there will be a win-win situation" (I12).

Besides, it is essential to interest actors joining who can bring the most value to the network, "how do you make it easy for the target group?" (I7). This perspective is shared by I8, who clarifies that before other actors are interested, "you always start with a customer" (I8). For I17 getting other actors interested "is about reaching out to operators, introducing them to your manifesto" (I17). For this reason, I8 sees the platform his company is building as a middleware platform, not a MaaS app. If the platform focuses on the "creation of new value" (I8), then the platform's customers will tell their customers about it. That means "the services are visible to any application or website that connects to our platform" (I8). So, the approach is to create an open marketplace for other actors to join. I12 adds that trust is one crucial factor and that it will be "more of a problem of trust in us" (I12).

Enrolment (Views on Actor Integration and Onboarding)

From a legislative perspective, "there are no rules or needs to have any kind of permission or license to enter into the market […], it's all based on the contract between the parties" (I4). Thus, it is about creating value for all the parties involved in the network. I8 states, "to create the most value, you need to do level three integration" (I8). This value is created by having an "overview of the services, targeting the customer value piece" (I8). I8 complements that "there are some value propositions, you can only do with level three" (I8). The depth of one integration is always associated with integration efforts. It should not be underestimated, as stated by I7 "many people always say that such an API connection costs nothing and is fast […], but we all know by now that such an API connection is always associated with effort and the effort is of course also associated with costs" (I7). Additionally, I8 recognises that currently "many city projects with different technology platforms, haven't created the demand that there was hoped. So now I think the mobility providers are being a lot more careful about who they integrate with" (I8).

Existing skills and knowledge gaps are also causing this. I7 articulates that it can be difficult sometimes, "providing the resources to manage this integration from both sides" (I7). It is important to understand that integration is not just about technical factors, the other actors need to "understand how the transport system works […], they have to make tech platforms work in accordance with all the rules and regulations of the area as well" (I17). I12 recommends prioritising "begin with public services […], then go towards the ones who will win more with the project […], and in the end, we will work with the ones who will win less" (I12). From a technical point of view I12 recommends creating "a data fabric or data lake there, and then you organise the data there in a way that is going to be easier to integrate" (I12).

This will also help in the future to make it easier when integrating other MaaS platforms in the context of MaaS roaming.

Mobilisation (Views on Activities and Evolvement of the Network)

Considering the activities and evolvement of the MaaS business actor networks, I4 comments from a legislative perspective that “there is no culture of working together or cooperation or developing services together […]. There is also no know-how on how to create these solutions together” (I4). According to I7, that can also be caused by a lack of shared understanding of the solution, particularly “in terms of technical understanding” (I4). For these reasons, “users need to learn new habits, but also, the operators need to learn new habits” (I4). This requires leadership in the form of a MaaS champion to go one step ahead so everybody else can follow. I12 has also observed such a champion “we had a group member, that is (name of group member) and they are pushing MaaS a lot. So, they help us understand some questions that make it easier for us to deploy the public MaaS” (I12). However, I12 observes that “taking the lead can be dangerous” (I12). Particularly, liability questions can be challenging in this context: “I’ve had or been in situations where we’re working on a city-based project and the city said, well, we’ll collect the money, but we’re not taking responsibility for fraud” (I8). That sometimes causes a lack of leadership that would help to evolve the MaaS business networks, “I think there is a lack of general leadership at the city, regional and state levels in terms of mobility” (I8). Regarding user activities, I17 reports that ways of increasing people’s engagement with the platform could be done, for example, through discounts or vouchers. However, I17 highlights that data security and privacy can be hindering here, “especially with the regulations of GDPR, is also very sensitive. You can’t just reach out to someone or send someone an email” (I17).

Key Barriers, Strategies, Learnings and Future Vision

In CS+, diverse barriers have been observed by the MaaS SMEs in all three dimensions of technology, social and policy. From a legislation point of view, I4 sees the most significant barrier “to set obligations to grant access to interfaces, because operators are not ready to voluntarily agree on those terms” (I4). To overcome that, I4 suggests that it would be helpful to set “some kind of minimum standard so that they would not need to negotiate also the technical solutions every time” (I4). I12 adds that it is also about the lack of openness of data and standardisation. Here, I12 particularly emphasises that “their biggest challenge has been until now, to integrate the public operators and some other public bodies” (I12). The strategy I12 adopted has been “to integrate them into a group of working and conduct the project in a way that they feel okay” (I12).

I8 clarifies that the missing standardisation is not always caused on purpose. It is based on “how you architect your technology” (I8). I8 stresses that “the architectural design and how you build your platform enable you to address that particular issue” (I8). Moreover, this can be released through customer service and added value “because you cannot compete with the services from Uber and other big platforms” (I8).

These technical challenges also influence the time and delivery of MaaS projects. Concretely, I7 reflects, “imagine that as a provider you have certain slots that you plan for different MSPs. But then it happens that the MSP to be planned suddenly does not have an API integration ready” (I7). This requires flexible planning that also considers the MSPs' reliability. The resulting strategy is “you set up a roadmap in which you still have slightly flexible partners behind it that you can bring in” (I7).

Lastly, key barriers are seen by I17 also in the social space concerning the acceptance of users and their travel behaviour as one of the biggest challenges, “one of the biggest problems is getting people to change their perspective on travel and behavioural change, trying to get people to move away from using private services and mobility and move on to public and shared mobility option” (I17). I17 concludes that “MaaS alone and technology alone in isolation will not create behavioural change” (I17). To overcome this barrier, I17 suggests “to teach people, educate people and sensitise people on different ways of transport, and how they can move around” (I17).

In CS+, different learnings were reported by the MaaS SMEs. For example, I8 reports that while regulation might be important to oblige providers to open up their interfaces, there should be “also a measurement of success, […] to set some objectives that say 20% of sales is the target to have through other channels” (I8). I4 contemplates that such measurements in the ecosystem are written into rule books which are currently being developed independent from legislation, “the parties themselves […], they are creating rule books, so they are creating soft law measures, how to make that data sharing, but not setting it in a legislation level” (I4). This kind of cross-collaboration is also observed by I12, who sees that “they are working for me in some way. And I am working for (them) because I am integrating all my public transport into a MaaS system. So, making the economic conversations or the insurance regulations easier” (I12). This creates win-win situations which can be seen as another best practice and learning “the main advantage is that many players want to introduce the public transport system in their offers” (I12).

In this context, I7 reports the learning that being a neutral provider “who already had a certain reputation somewhere, who had a certain size, they were simply the first ones to be spoken to” (I7). This can be a crucial success factor when building a MaaS platform. On the user side, one key learning has been the education and breaking of habits, “trying to educate them and bring them on board has been one of the very challenges, and I think that is why we also tried to partner with (company), to bring in ways to encourage people to start using the platform, the MaaS platform as well as encourages the use of public transport” (I17). The adoption can be also increased through marketing campaigns and education “they've probably had their car for a very long time, and they don't know what is different for now. So, trying to educate them and bring them on board has been one of the very challenges” (I17).

The SMEs have mentioned several topics for the future. I4 sees that through legislation and granting access to interfaces, "open markets and fair competition" (I4) will be enablement in the future, allowing MaaS roaming. This topic of MaaS roaming is also seen by I7, who would see themselves as "we actually want to be a roaming partner via blockchain technology" (I7). Also, I17 would like to enable MaaS roaming in future by "integrate different areas into the system to be able to attract everyone to use the transport systems" (I17). When these different cities can be integrated, it can also be a tool for future city planning. For example, the generated data can also "help them handle the number of vehicles on the street and so on" (I4). For this reason, one major topic will be future data sovereignty and the ownership of such solutions. I17 states, "the city must always be the owner, must be well equipped to be able to bring about this change and at the same time connect the private companies" (I7).

Having data sovereignty helps to "further develop services, because nothing is more difficult than making services better for the end customers than when you don't have the data" (I7). However, by overcoming that, MaaS will solve routing problems and be "a good tool to improve public transport and the mobility ecosystem" (I12). The ecosystem should be a fair and inclusive, open ecosystem of national or local providers. It should "encourage the market to find the areas of value for the consumer" (I8). Here the market will saturate, and technical improvements concerning the reliability will be made, as described by I12 "I suppose we are going to improve a lot of the information for the citizens" (I12). I17 describes that the MaaS platform will be much more than just one app in the future. It will help to organise the mobility needs and helps "to find a place to eat […], and it understands what the user wants in a specific area and at a specific time" (I17). According to I17, "that would be the epitome of MaaS" (I17).

CS+ Summary

Table 22. Summary of Individual Themes of CS+

Themes	*Key Observations and Insights*
Problematisation	➢ Outside-in perspectives to introduce additional aspects. ➢ Insights of lawyers, consultants and business owners. ➢ Definitions and ecosystem views are shared.
Interessement	➢ Policy questions are important, and providers must join MaaS solutions legally. ➢ The obligation is bi-directional, meaning MaaS platforms need to also open up for potential actors. ➢ Introducing manifestos and a marketplace to interest actors have been a valuable strategy.

Enrolment	➢ No legislative rules exist. Enrolment is based on contractual agreements. ➢ Depth of integration is always associated with integration efforts and should not be underestimated. ➢ Skills and knowledge gaps are observed. Platforms aim to make integration as easy as possible.
Mobilisation	➢ Culture and cooperation have been seen as factors hindering the evolvement. ➢ Users and operators need to learn new habits. ➢ Fears of losing power positions sometimes caused by lack of leadership.
Key Barriers and Strategies ➢ *Social* ➢ *Technical* ➢ *Policy*	➢ Barriers in all three dimensions have been reported. ➢ Legislation sees the most significant barrier to setting obligations to grant access to interfaces which can be addressed by setting minimum standards. ➢ For business owners, it matters the most how the technology is architected. ➢ Consultants see technical challenges and on-time delivery as being crucial factors for the success of MaaS platforms.
Learnings and Future Vision	➢ Learnings include, setting KPIs for interfaces, creation of rule books, cross-collaboration and creating win-win situations. ➢ The future views include MaaS roaming, a tool for city planning, MaaS platform ownership and data sovereignty and a fair and inclusive ecosystem.

No actor network was created because these outside-in perspectives supported the creation of other actor networks but did not have their own.

5.2 Evaluation of the Cross-Case Actor Network Results

This section is based on the within-case analysis of the individual cases of the previous section and evaluates the results using ANT. Each subsection starts with a summary table that introduces the purpose, the characteristics from the literature and the outcome.

Here the findings are compared, mapped back to literature, and interpreted in their broader context. The section is structured based on the four moments of ANT translation (problematisation, interessement, enrolment and mobilisation).

Subsection 5.2.1 details how the different cases understood MaaS and compares the goals and backgrounds. Subsection 5.2.2 evaluates the interessement approaches of the cases by outlining how they approached MaaS and got other actors interested in joining their network. Subsection 5.2.3 evaluates the cases' enrolment approaches, comparing how different actors were integrated. Finally, Subsection 5.2.4 compares the different mobilisations happening inside the MaaS business ecosystem. Here, it is emphasised how different activities help to evolve the network.

5.2.1 Problematisation (MaaS Definitions and Conceptual Understandings)

Problematisation is the first moment of translation of ANT. The following table presents the evaluation of the problematisation cross-case results. After presenting the outcome, the empirical findings are detailed.

Table 23. Evaluation of Problematisation Results

Purpose	*Characteristics from Literature*	*Outcome*
Problematisation *(Callon et al., 1983): The purpose of problematisation relates to the process of formulating the problem or network that needs to be researched.*	➢ Nine MaaS characteristics of Jittrapirom et al. (2017) ➢ MaaS characteristics of Giesecke et al. (2016) ➢ Conceptual understanding of Kamargianni and Matyas (2017)	Confirmation: Participants (actors) have established relationships with the MaaS Provider through OPPs. In addition, most participants' definitions are consistent with the characteristics from the literature. While the context and backgrounds of the individual cases differed, they all shared similar goals.

Figure 28 presents the problematisation approach of the cross-case report. On the top are the different actors that are part of the MaaS business ecosystem. The MaaS provider constitutes the particular lens through which this research looked at the cases. All other actors of the MaaS business ecosystem (digital service providers, mobility service providers, regulatory organisations, the broader business ecosystem, and the customers & users) are connected with the MaaS provider through the OPP. Every actor is in a relationship with the MaaS provider because they see added value generated by it. However, in this relationship, different barriers have been experienced, through which learnings were made, and the future vision was generated. The following passages compare the definitions and conceptual understandings of the different cases and report the individual cases' goals and backgrounds.

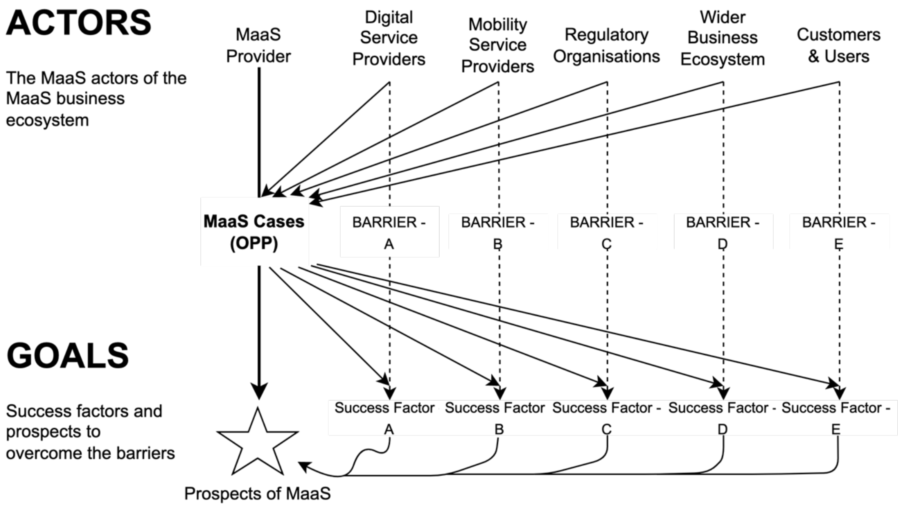


Figure 28. Cross-Case Problematisation

Comparison of MaaS Definitions, Conceptual Understandings, and Goals

Many definitions were given in the researched cases, emphasising different aspects of MaaS. After reviewing them, those definitions can be divided into two types. The first type of definition describes the MaaS concept itself, including its functionality. Here, MaaS is defined as the following. In this context, I1 defines MaaS as “simple access to mobility that is as barrier-free and obstacle-free as possible, which should function independently of the means of transport and ultimately also independent of the provider” (I1). Compared to that, I2 emphasises “the use of different modes of transport as easily and hurdle free as possible in order to organise one’s private mobility or professional mobility” (I2). I16 highlights “the integration of mobility offerings in the region with digital provision” (I16) as the concept’s most crucial aspect. These definitions are largely consistent with the definitions from the literature. For example, Jittrapirom et al. (2017) describe the integration of transport modes, usage of technologies and multiple actors, which can be located in the definitions of the interviewees above. The same applies to the characteristics nature of travel and interoperability of Giesecke et al. (2016), which can be found in the above definitions.

The second type of definitions for MaaS interpret the concept of MaaS more from the user side. Here, I3 underlines that "the main concept of MaaS is putting the user at the centre and really being able to provide him with all mobility solutions from one source on one platform as simply as possible [...]. So the user can choose the means of transport to get from A to B and really have access including billing" (I3). That definition is shared by I6, who says that "it helps you to get from a place A to B, with having the bigger picture view" (I6). In such a bigger view according to I14, "everything should be integrated and shared in one app […]. I'd like to have one registration and use all of it" (I14). This creates a place where "a user can compare all the transport network in one go" (I5). I9 adds to that that the "no matter what my mobility needs are, I can get the right vehicle, the right offer, at any time and for any need, and that I can use and book it at a very low threshold" (I9). I13 sums it up stating that MaaS "is about providing you as a traveller all the direct access to all mobility options you have, including that of your own vehicle, of your own bike, and what else you have […], giving you access to the best suitable, sustainable, affordable solutions for you to get from A to B" (I13).

Those definitions reflect more on the sustainability and end-user perspectives of Giesecke et al. (2016). Jittrapirom et al. (2017) characteristics of demand orientation, customisation, one-platform, registration, and personalisation can also be located in the abovementioned definitions. However, the characteristic tariff option of Jittrapirom et al. (2017) is not reflected in the data anymore because the focus of the concept shifted "it is not making it a subscription model where you have an all-you-can-eat service for all kinds of public transport and perhaps micro-mobility" (I13).

Besides this observation, a large consensus between the participants concerning MaaS definitions and characteristics is noticed, which means that the concept of MaaS is understood similarly.

By comparing the conceptual understanding of the case studies with the conceptual definition of the MaaS business ecosystem by Kamargianni and Matyas (2017) and the findings of the SLR of this thesis, many actors are represented in the data. As this study focuses on public-private partnership case studies, the business ecosystem has been described through that lens. Generally, various actors in the core, the extended and broader ecosystem, have been mentioned. For example, in the core, the backbone of public transport is mentioned, the users and customers and the private MSPs (I1, I3, I10). Also, the extended ecosystem has been named, including digital service providers, and bundling (I1, I9).

I1: "desire to launch an app relatively soon that offers different Mobility Service Providers (MSPs) in a deeply integrated way to customers and we have used a software solution for this."

I3: "the backbone for MaaS is still public transport."

I9: "topic of the ecosystem […], we bundle these offerings and enable users to use them with a single login and registration."

I10: "we look at it as the foundation of public transport […], bus, tram, train, walking, cycling and e-scooter."

Further, actors of the broader ecosystem have been named, including regulatory organisations, research, and investors (I5, I13, I14). Overall, it has been observed that some cases were struggling to understand "where we fit in that MaaS ecosystem" (I15). For the MaaS providers, being the core of the ecosystem, it became clear that they would need a solution that has all the mobility and transport options available in their solution (I9, I11).

For most case studies, the best way to achieve that has been to create an app that unifies the public transport ecosystem with the shared mobility ecosystem, creating a combined MaaS ecosystem (I1, I14). The following evidence underlines that:

I5: "there are a variety of other stakeholders involved in each pilot, some are common amongst all the pilots, and some are specific to each MaaS implementation."

I11: "the classic ones like buses and trams and undergrounds and all the micro-mobility players."

I13: "the ecosystem is about all the companies and the government, your employer, perhaps even the location where you live, and your housing regulations."

I14: "we have the public transport ecosystem, which is quite good and successful in the city. On the other hand, there is a second ecosystem, and it's the shared mobility ecosystem. Currently, both parts have started to work together."

Comparison of Goals and Backgrounds of the Individual Cases

While the context and background of the individual cases differ, they all share similar goals. The main goal of the cases involved creating a platform and developing strategies to bring more people to the public transport system, triggering a mindset change for citizens (I1, I6, I11, I15). Most cases have started with pilots collecting evidence and experiences before continuing with a larger-scale solution (I10, I16). I10 targeted the pilot "the region, doing lots of research, trials, testing and true implementation" (I10). I16 focused more on kicking off "a series of pilots to collect evidence on what does a MaaS offering look like?" (I16). In these pilots, it was found that more cooperation is required in a public-private partnership to ensure they do not just work independently (I15, I18).

This public-private partnership aimed to deliver integrated, collaborative MaaS for the regions by replacing existing apps to achieve the societal goals of a local region (I8, I18). To realise this, several cases formed alliances in regional transport partnerships, working together with local MSPs and local authorities. As the different cities started at different points in time with different contexts, the maturity levels of their solutions varied. In some cases, they were preparing the pilot, others finished the pilots and were planning the first rollout, while others already had an operating platform with many daily users. All cases interviewed were financed by the cities or through public money, which came through funds. However, the goal of these MaaS platforms was not "making money but use it as a steering instrument for mobility in cities and agglomerations" (I2). A 50/50 split between cases using a commercial digital services provider and own custom development has been observed in realisation. The following insights underline this:

I1: *"strengthen public transport plus the environmental network, for example, everything that is not individual transport, in order to ultimately support the major goal of the mobility transition."*

I6: *"promote companies that are already building and planning applications to integrate our APIs and our services to create a platform."*

I8: *"address the mobility challenge in which shared mobility services are underutilised and with the capacity to serve more customers."*

I11: *"to convince people to change to public transport."*

I15: *"we have this goal to become a lot more integrated."*

I18: *"deliver an integrated, collaborative, end-to-end journey planner for the region […] including booking, ticketing and payment functionality with contextual information relevant to them."*

5.2.2 Interessement (Approaches of the Cases)

Interessement is the second moment of translation of ANT. The following table presents the evaluation for the cross-case results of Interessement. After presenting the outcome, the empirical findings are detailed.

Table 24. Evaluation of Interessement Results

Purpose	*Characteristics from Literature*	*Outcome*
Interessement *(Callon et al., 1983):* *The purpose of Interessement in the context of MaaS relates to the process in which the MaaS provider outlines reasons why joining the actor network could be beneficial for the other actors.*	➢ Recruiting process which establishes roles and power relationships Law and Callon (1988)	Mixed Pattern: Participants (actors) had diverse strategies to get actors interested. These recruiting strategies varied based on the solution, the people, and the maturity of the platform.

The strategies to get other actors interested in joining the actor networks of the individual cases varied. Activities3 of the cases to grow their network had been to map out their existing ecosystem in the region, reaching out to the different actors and introducing them to their manifesto and business case (I17, I18):

I17: "it is about reaching out to operators, introducing them to your manifesto."

I18: "simply map out all of the different providers within the ecosystem that are offering mobility services."

For example, I11 stated, "we know almost all companies and we do have contacts" (I11). The actors usually meet at industry events and thus exchange regularly, "you also meet each other at industry events, where you also have the exchange" (I3). I9 added that they are in contact with all mobility providers:

"You can assume that if there is a player on the market, our partner manager has already spoken to them, knows them and is in exchange with them" (I9). Thus, most participating cases conducted active partner management. A tendering procedure had to be established for most cases, including transport-related criteria such as a comprehensive mobility mix and other requirements, including the interface, size, and growth strategy (I1, I9). While some cases had issues persuading or getting in contact with larger MSPs, it had been the other way around for others with a prominent name. For example, they created a continuous interest expressions procedure inviting all the MSPs to express their interest in being part of the case (I1, I9):

I1: *"a kind of application procedure was advertised, and we thought about what requirements an MSP should and must meet in order to be able to integrate with us."*

I9: *(1) "a continuous interest expression procedure, which is a kind of call for tender that we have continuously publish and also update, in which we invite all mobility providers to express their interest in being part of the (CS3) network."*

For those who had issues persuading other MSPs, their strategy had been to show the interested actor the solution's potential, including the benefits and value the other actor would get by joining, "we show them the potential for rising profits and rights" (I14).

In some cases, they were cooperating cases with a digital service provider. The benefit of the interessement stage was that the cases who cooperated with a digital service provider could use their existing actor network. To achieve the wished mobility mix and the critical mass for the cases, the cases used their neutral position of power to create working groups or enact a committee or board where they gathered with interested MSPs to discuss different ideas.

I6 describes this as “we enacted some sort of a committee or a board where we just gather with the mobility service providers and discuss different ideas” (I6). I10 mentions that throughout the process, “we have several working groups already […], any actors that are part of that, which are most of them in the region, are a part of that group” (I10).

In these boards, challenges and strategies have been discussed, including commercial, technical and policy topics. Then the prioritisation strategy for the enrolment was addressed.

5.2.3 Enrolment (Actor Integrations and Onboardings)

Enrolment is the third moment of translation of ANT. The following table presents the evaluation for the cross-case results of Enrolment. After presenting the outcome, the empirical findings are detailed.

Table 25. Evaluation of Enrolment Results

Purpose	*Characteristics from Literature*	*Outcome*
Enrolment *(Callon et al., 1983):* *The purpose of Enrolment in the context of MaaS relates to the process in which the other actors accept the MaaS provider and their role within the network.*	➢ Through successful enrolment, a network of alliances is formed (Alexander & Silvis, 2014) ➢ Inscription happens (Sarker et al., 2006)	<u>Mixed Pattern:</u> The participants (actors) manifested a three-step enrolment process to inscribe the actor network. A formation of alliances was observed. For this, the use of aggregators was essential.

The enrolment phases of each case can be summarised in three main steps: (1) the initial expansion and procedures, (2) the prioritisation and funnelling and (3) readiness & depth of integration.

First of all, for the integration, there has been an initial expansion and establishment of the procedures in the different cases. The initial expansion of the individual actor networks started by reaching out to new actors and having an initial conversation with them regarding how they see themselves as part of the network (I16, I18). Other cases tendered a concession requiring integration if they wanted to operate in the city, "we were tendering out a kind of concession and then effectively demanding integration on the municipal platform with it" (I1). As different partners were evaluated, one of the critical considerations was whether the partnership was commercially attractive. An essential factor in this context is the readiness of their APIs for the integration and if they already had agreements in place (I13, I16). This initial expansion resulted in a list of promising partners for which two types of contracts were created. The first type of contract was a letter of intent (LOI) to evaluate the potential partnership, while the second contract included the commercial model (I2, I18). If an agreement is reached, the new actor would be handed over to the platform provider, to the city or to a digital service provider (I18). The following statements underline this:

I2: "there was a LOI (Letter of Intent) that they say, yes we want to and we want to support them. […] And then there was a commercial contract or a commercial part where the tariffs and the compensation were determined."

I13: "is it commercially interesting? […] How ready are their API? […] Do they already have agreements in place?"

I16: "we started with asking what they want to do from a MaaS perspective in very clear terms of how they see themselves integrating into the region as a whole in the multi-modal setting."

I18: "we have started conversation between them and our platform provider around integration and the commercial deal."

The second type of enrolment strategies can be categorised as prioritisation and funnelling. After the initial agreements were set up, there were technical requirements that had to be fulfilled by the participating actors. Based on the degree of fulfilment of these requirements, the actors were prioritised in the implementation roadmap (I9). One of these criteria was the importance of a partner in the transport system (I18). Through this, a funnel of actors is created and prioritised in a phased approach. Here, all the interviewed cases started with public services, which will significantly benefit from the project, moving on to those private MSPs, and finally to those who will see the most negligible benefit (I12). The following evidence underlines this:

I9: *"there are of course technical requirements that must first be fulfilled on their side, such as the authorisation of all interfaces […]. Depending on the degree of fulfilment, the providers move up the implementation roadmap, so to speak."*

I12: *"we begin with public services […], then we go towards the ones who will win more with the project […], and in the end, we will work with the ones who will win less."*

I18: *"we have one bus operator that runs over 90% of the bus services […] if we don't have them on board, that's a big element of the transport system that we'll miss."*

The last enrolment phase includes the readiness and depth of integration, in which the classic project management happens. The goal observed between the cases has been creating a seamless user experience (I2, I8). To achieve this seamless experience, all the services should be consumable and accessible without leaving the app. Therefore, the cases focus on achieving level three integration (most deep integration), delivering the most value to the users (I8). Additionally, reaching a critical mass with a diverse of actors is the key to creating the services for the users.

However, integrating the actors is considered a challenging task with a unique system, individual requirements, and other factors (I14). To achieve that, efforts have been made to integrate aggregators instead of integrating each actor individually (I11). On the platform side, the goal had been to make the integration easy and to be able to scale more quickly and efficiently:

I2: "ideally, the booking, the payment [...] and also the reservation must all be possible without jumping off in the MaaS app."

I8: "to create the most value, you need to do level three integration."

I10: "we need a product with almost everything we need or that the users need […] integrating every single one is probably a big piece of work and maybe not worth all our time."

I11: "we try to somehow do that more effectively and integrate one platform, that already includes six players."

I14: "integrating all public providers is tough. Every provider has a unique system; they have their own requirements and so on. And now, we are facing the most critical phase of the project, and it is to create a business model."

5.2.4 Mobilisation (Activities and Evolvement of the Networks)

Table 26 presents the evaluation of the cross-case results of Mobilisation.

Table 26. Evaluation of Mobilisation Results

Purpose	*Characteristics from Literature*	*Outcome*
Mobilisation *(Callon et al., 1983):* *The purpose of Mobilisation in the context of MaaS relates to the process in which the actors or alliances establish representatives to avoid betrayal in the actor network.*	➢ Possibility for actors to create individual sub-networks (Burgess & Tatnall, 2002) ➢ Establishment of representatives to avoid betrayal in the actor network (Callon, 1984)	Mixed Pattern: Majority of participants (actors) established MaaS champions as spokespersons. These influenced the branding of the platform.

Mobilisation is the fourth moment of translation of ANT. Depending on the individual cases' maturity levels, the network's mobilisation has been observed in different forms. While in some cases, no, or minimal mobilisation happened, others report pull and network effects. This effect increases the more the case becomes visible to the general public. One example is that one of the cases became more visible once the app was launched and received good ratings, "the rating of our app in the app store is above average in relation to others" (I1). Other cases reported that the platform's success has not gone unnoticed. Potential partners heard through an informal exchange like word of mouth about the platform, requesting integration into the platform (I3, I11):

I3: "many also approached us and asked, may we integrate?"
I11: "so they are calling each other, asking, how was the work with (CS9)?"

When growing the network I9 reported that whenever the platform launches new providers or stations, they see a significant increase in use and engagement of the platform, "we always see when we go live with new providers or when we go live with new stations that there is also an impulse there." (I9). Another critical factor has been the branding of the platform being influenced by spokespersons or MaaS champions. They help to establish trust in the regional transport partnerships and are instrumental in pushing the MaaS business ecosystem forward. MaaS champions have been advocating for MaaS and are crucial in attracting other stakeholders into the network. Further, they are the key to success as they are decision-makers and can help trigger organisational cultural and behaviour changes (I9, I12, I18):

I9: "our CIO, who also heads the area in which we are suspended, has become the CIO of the year. That means that he is present, he is visible, he simply attracts conversations with such players through his exposure and really through his profile. And we have a partner manager who conducts these talks and is also incredibly well networked with others."

I12: "we had a group member, that is (name of group member) and they are pushing MaaS a lot. So, they help us understand some questions that make it easier for us to deploy the public MaaS."

I18: "we have a couple of key champions, within the authority, the politics, and senior leadership side, who are very supportive of the concept of MaaS and have helped to bring other stakeholders along that journey and convince them that this is the right things for us to be doing."

5.3 Evaluation of Cross-Case Barrier Results

This section addresses the in-depth barriers that have been deductively derived from literature (*see* Section 3.7.4) and emerged from the within-case analysis found in Appendix H. In the following, the different themes are introduced and then the cross-case findings in combination with the literature are disseminated.

The barriers can be summarised in three main themes, ***Technology and Data (TD)***, ***Social and* Cultural *(SC)*** and ***Policy and Regulation (PR).*** Each of those themes has multiple *subthemes* underneath. Table 27 shows these overarching cross-case themes of barriers.

Table 27. Overarching Cross-Case Themes from the Literature (Gebhart et al., 2023)

Themes	*Subthemes*
Technology and Data (TD)	*(TD1) Data Security and Privacy*
	(TD2) Lack of Openness of Data and Standardisation, Data Silos, and Interoperability
	(TD3) Modernisation of ICT Infrastructure, Internet Coverage, Real-time Information Available
	(TD4) Unclear or No Platform Architectures Existing
Social and Cultural (SC)	*(SC1) Acceptance of Users, Travel Behaviour and Lack of User Trust*
	(SC2) Competition, Losing Monopoly Position, Control, and Influence
	(SC3) Difficulties for Users Related to Technologies
	(SC4) Missing Collaboration
	(SC5) Missing Leadership and Vision
	(SC6) Skills and Knowledge Gaps
Policy and Regulation (PR)	*(PR1) Demand Estimation, Creation of Business Models, Tailoring of Services*
	(PR2) Legal Issues, Bureaucracy, and Institutional Barriers
	(PR3) Poor Governance Frameworks, Policy, and Regulation Challenges.

5.3.1 Evaluating Barriers to Technology and Data

Technology and Data (TD) consists of four *subthemes* (TD1) - (TD4). The findings of each theme are evaluated with the literature in the following.

(TD1) Data Security and Privacy

Data Security and Privacy are essential when building a MaaS platform. The following table presents the evaluation of the cross-case results of this subtheme. After presenting the outcome, the empirical findings are detailed.

Table 28. Evaluation of Data Security and Privacy (TD1)

Purpose	*Characteristics from Literature*	*<u>Outcome</u>*
Data Security and Privacy *(Cottrill, 2020):* *The purpose of data security and privacy is to ensure that MaaS services are built compliant to rules and regulations.*	➢ Gace and Babic (2020): Barrier can only be explored after MaaS platforms are widely deployed in practice.	*<u>Confirmation</u>*: This study researched the biggest MaaS platforms in Europe in practice.
	➢ Cottrill (2020): MaaS solutions need to ensure that privacy issues are raised early.	*<u>Amendment</u>*: Before the implementation, extensive workshops were held between all the parties to ensure all necessary precautions.
	➢ Smith and Hensher (2020): Need to resolve security and privacy issues .	*<u>Confirmation:</u>* Participants have established strict rules and regulations to resolve issues.
	➢ Huang (2022): Transparent data privacy strategy.	*<u>Amendment</u>*: Data privacy strategies were based on the need-to-know principle.
	➢ Polydoropoulou, Pagoni and Tsirimpa (2020): GDPR to overcome privacy barriers.	*<u>Confirmation:</u>* Implementing and ensuring GDPR has been the number one priority of the participants.
<u>Conclusion:</u> *Participants saw data security and privacy as key barrier, resulting in the introduction of strict rules and regulations. In addition, public companies were held to higher standards.*		

When building a MaaS solution, the importance of data security and privacy are of paramount importance. MaaS services are built to share personal travel information (Cottrill, 2020). I16, for example, reports that the MaaS offering "at this very core, knows exactly where someone is and makes the best recommendation possible so that they can make an informed decision. You know that there are challenges around that as a whole" (I16). This is also recognised by Gace and Babic (2020), who outline data security and privacy as a challenge that can only be explored after a MaaS platform has been widely deployed in practice. Moreover, Smith and Hensher (2020) highlight the need to resolve privacy and security issues for a MaaS platform. This evidence was collected to determine how the companies have addressed data security and privacy. To ensure data privacy, the participating companies have established strict rules and regulations, which must always be followed (I1, I2, I7, I8). Even before the implementation, extensive workshops were held between all the parties to ensure all necessary precautions were taken. As most parties involved were public companies, they were even held to higher standards with the General Data Protection Regulation (GDPR) as a basis (I7, I9). One reason is that the MaaS provider acts as an integrator. These statements underpin this:

I1: *"as a municipal company, we also have a certain reputation, especially when it comes to data security. This means that we have also set very strong rules here and said that certain data protection rules simply have to be followed."*

I2: *"there were whole workshops between the parties before we even started and it was clear there that it has to be taken into account."*

I7: *"GDPR is an incredible sword that hovers over everything. In all phases of building an ecosystem, you have to make sure that you take the right steps."*

I9: *"the focus was often on the topic of data protection, […] because of course they pay a different amount of attention to a municipal player than they do to a small company."*

Based on the findings of Cottrill (2020), new MaaS solutions must ensure that privacy issues in response to GDPR are raised early and that all involved actors are working with consistent and transferrable approaches which are communicated to the user. These findings are in line with the findings of this study. For example, I3 reported that “the solution has no tracking at the back, so the users are not tracked, and that was very important to us from the beginning, that this does not take place, and if we want to do this, the customer must actively decide” (I3). I5 highlighted that “we have to be very clear with the user as to where their data is going […], what we definitely try to do as much as possible is not to have to provide personal data to the transport operator if they don’t require it” (I5). This is in line with Huang (2022), who reports that a transparent data privacy strategy can help to increase the users’ willingness to share their information resulting in a higher acceptance rate.

Polydoropoulou, Pagoni and Tsirimpa (2020) state that establishing GDPR contributes to overcoming privacy challenges. The findings of this study clarify that GDPR is the number one priority of the cases; as I10 states, “more partners, more parts to the system, more subsystems; there are more vulnerabilities. I think we have a very low tolerance to risk as public authorities” (I10). Even additional requirements were set when creating the MaaS, “we saw the introduction of GDPR a while ago now, but with other expectations. And as part of our procurement, we expect the supplier to have ISO 27001, PCI DSS, which is a payments protection and cyber essentials plus.” (I10). I17 added that “especially with the regulations of GDPR, is also very sensitive. You can’t just reach out to someone or send someone an email; they’d obviously be wondering, you know, where did you get my email?” (I17). I3 reported that they even “decided where the server would be located” (I3), because of their requirements.

However, I6 observed in their case that the digital service provider was able to "implement all of the required procedures" (I6). Nevertheless, I13 states that it is important to "agree on security on privacy, payments, and availability […], before you start any integration" (I13).

An additional challenge observed in the context of data privacy and security was the issue of data monetisation. While some MaaS operators sought to monetise their service by using and selling user data, this was considered inappropriate. For this, I8 had to navigate this tension between providing a valuable service and respecting user privacy, "now the problem comes when you say, well, I want to use that data, and this is again monetisation. If you are only making money on ancillary revenues, then some MaaS operators are saying, well, we want to be able to mark, use, and sell that data. That is wrong" (I8).

Cottrill (2020) findings revealed that the full benefits can only be released if these processes are driven by and managed in the context of agreed data procedures. This data management will become increasingly complex and sensitive with multiple providers. However, I12 claims that it will ultimately be a problem of trust, as the technology problem can be solved.

(TD2) Lack of Openness of Data, Standardisation, Data Silos, and Interoperability

Lack of openness of data and standardisation, data silos and interoperability (TD2) can be a barrier to MaaS providers. The following table presents the evaluation of the cross-case results of this subtheme. After presenting the outcome, the empirical findings are detailed.

Table 29. Evaluation of Lack of Openness of Data, Standardisation, Data Silos and Interoperability (TD2)

Purpose	*Characteristics from Literature*	*Outcome*
Lack of Openness of Data and Standardisation, Data Silos and Interoperability *Servou et al. (2023):* *The purpose of this barrier is to address missing standardisation, data silos and interoperability.*	➢ Servou et al. (2023): Heterogeneity of datasets, data standardisation and scalability issues.	*Amendment:* Unique and custom platforms are causing high integration efforts for MaaS providers.
	➢ Gace and Babic (2020): Openness and standardisation of data are requirements.	*Confirmation:* Findings show that standardisation and openness of data are crucial.
	➢ Ghazy et al. (2021): Missing metadata to enable interoperability, data silos are present.	*Amendment:* Continuous interface changes are tedious and require multiple adaptions.
	➢ Kamargianni and Goulding (2018): Need to establish a central policy.	Mixed Pattern: Participants question country-wide policies but are part of initiatives.
	➢ Karlsson et al. (2017): Need of overarching standards.	Amendment: Providers are starting to develop harmonised APIs.
Conclusion: *Participants report that they are struggling with this topic and that the unique implementations hinder the development of standardisation. From their point of view, expanding the ecosystems will become the biggest challenge.*		

According to Servou et al. (2023), the main challenges when integrating mobility services are caused by the heterogeneity of datasets, data standardisation and scalability struggles. This aligns with I1, who noticed that “there will have to be some kind of standardisation needed” (I1). There was an explicit requirement “that when this pilot is completed, no matter what the successor solution will be, it must again be based on (regulation) and must take into account the offer for public routing” (I1).

To achieve that, standards for APIs and system interoperability play an important role. I10 supports this, stating that “standards for APIs, open APIs, encouraging operators to join MaaS and for interoperability and supporting technologies are also important” (I10). However, the findings revealed that some more traditional operators might not have their APIs ready. I10 states that “some of our more traditional operators don’t have potentially open APIs ready to be consumed externally” (I10). In addition, the process of integration is described as unique for each operator, requiring a significant amount of effort and cooperation between the operators and the MaaS provider (I11, I12, I14, I17):

I11: “I cannot do one type of integration and then all the others can join easily. Every single integration will be different and you must work with them a lot.”

I12: “but when we go to the platform, each one of the partners of the platform has their API, their own way of working.”

I14: “integrating all public providers is tough. Every provider has a unique system; they have their own requirements and so on.”

I17: “so, it’s about 18 operators and trying to get compatibility of their systems to (our system) would have been a challenge. Because you’re trying to integrate someone who uses a different way of portraying that data.”

Thus, to ensure a successful implementation of MaaS, supporting the standardisation and openness of data is crucial. These findings align with the research report of Gace and Babic (2020), who highlight data-related challenges as the openness and standardisation of data as necessary factors for the MaaS development. In addition, the findings align with Polydoropoulou, Pagoni and Tsirimpa (2020), who identified the lack of data and APIs as significant barriers, demanding a thorough case-specific analysis.

Besides these standardisation issues, Ghazy et al. (2021) emphasise that the data in the MaaS ecosystem is heterogeneous, present in silos and not equipped with the metadata necessary to enable data interoperability. This is also backed by empirical evidence found in this thesis. One finding revealed that the continuous interface changes could be tedious and require multiple adaptions (I1, I2). Even though the first standardisations for data interoperability are being developed, it is still expensive to keep up with the changes (I2):

I1: "but with every change, the interface also changes, of course, and that makes it quite tedious."

I2: "we still have to spend (much money) to adapt it, because the standard for them is not yet such that they can invest once and then operate X MaaS systems with it."

In this context, another challenge, which will be addressed later, is the integration of local information sources. Here, on the one hand, some local schemes keep certain information to themselves to attract customers to their app, "we have to integrate more sources of information for those more local schemes compared to the national […]. But they'll keep the best information, like where specifically the bus route is on their route, for their own app because they want to attract customers to their app" (I5). On the other hand, some public service providers focus on controlling the MaaS ecosystem instead of encouraging an open ecosystem, "I generally think in public transit with PTOs, the focus has been on whether we want to control the MaaS ecosystem instead of participating" (I8). Here, still much work will have to be done in terms of policy and governance to ensure an open ecosystem and a seamless integration of each actor. For I8, "policy and governance, to me, is encouraging an open ecosystem" (I8). This results in data standards and protocols.

The seamless integration and interoperability following national and international data standards and protocols were already suggested by Kamargianni and Goulding (2018), stating the need for a central policy that the MaaS operators can adopt. Since then, different initiatives have formed, like the Mobility Inside initiative, which operates throughout Germany, intending to set up a nationwide platform. For example, I1 states they are "also involved in the Mobility Inside networking initiative, which operates throughout Germany and is setting up a nationwide platform" (I1). However, the belief in such initiatives is not shared. It is believed that if every country sets its standard, it will not work, "I personally don't believe in it, because if every country has the idea of setting its own standard, I don't think it will work well" (I3). Even further, I3 states that "(case country) is really too small for its own standard, if any it should be an overarching standard" (I3). The question, which was also raised by Karlsson et al. (2017), is who the responsible facilitator will be for such initiatives. Since then, a consolidation and shift have been observed concerning the MSPs. Individual providers are now being integrated into other mobility platforms and no longer have their API but rather have harmonised their technology by making a partner API available that can be accessed by the MaaS provider (I9, I15):

I9: "a few years ago, the providers were almost all seen separately next to each other, it is now common for individual providers to be integrated into other mobility platforms and many providers no longer have their own API, but instead have a partner API, a platform API that we can access."

I15: "we've got them harmonised by using the same supplier's technology with an API available."

The challenge will be in future how the ecosystem can be expanded so that it will become interoperable and can scale.

(TD3) Modernisation of ICT Infrastructure, Internet Coverage, Real-Time Information Available

TD3 represents barriers experienced concerning outdated IT infrastructure, IT systems, internet connectivity and real-time information. The following table presents the evaluation of the cross-case results of this subtheme.

Table 30. Evaluation of Modernisation of ICT Infrastructure, Internet Coverage, Real-Time Information Available

<table>
<tr><th>Purpose</th><th>Characteristics from Literature</th><th><u>Outcome</u></th></tr>
<tr><td rowspan="4">Modernisation of ICT Infrastructure, Internet Coverage, Real-time Information Available
Kamargianni and Goulding (2018):
The purpose of this barrier is to address outdated ICT infrastructure, IT systems, internet connectivity and real-time information.</td><td>➢ Kamargianni and Goulding (2018): Functioning ICT infrastructure required.</td><td><u>Confirmation:</u> Participants express the need to have more physical and technical infrastructure.</td></tr>
<tr><td>➢ Smith and Hensher (2020): Real-time information is required, and progress in MaaS projects was made.</td><td><u>Mixed Pattern:</u> Progress is observed; still, traditional companies lack technical readiness and, thus, real-time data.</td></tr>
<tr><td>➢ Ghazy et al. (2021): Data layer on top of infrastructure.</td><td><u>Contradiction</u>: Significant modernisation of backends is required to build such a layer.</td></tr>
<tr><td>➢ Hasselwander and Bigotte (2022): ICT tools and technologies are essential.</td><td><u>Amendment:</u> Especially supporting technologies and their deep integration pose challenges.</td></tr>
<tr><td colspan="3"><u>Conclusion:</u>
Most participants see TD3 as a barrier. Across the cases, a mixed picture of readiness was observed. Developing a data layer is far from reality as major backend modernisation is required.</td></tr>
</table>

Early in the academic literature, Kamargianni and Goulding (2018) highlight the need for functioning ICT infrastructure in cities. This starts from mobile network coverage and download speeds but extends to smart ticketing and mobility services. This is in line with the findings of I4, who sees the need for more physical infrastructure supporting new mobility services, stating that “we need the physical infrastructure to support, for example, cycling and e-scooters” (I4). However, it is also criticised on the company side that small companies do not have the infrastructure in place and need to invest much money to modernise their infrastructure (I2, I12):

I2: “it was simply a big problem to find out which MSPs are available in the three cities, how technically ready they are […]. They had not been technically ready and were not willing to invest in the pilot.”

I12: “the small companies don’t have the infrastructure. In (region), there will be more companies that don’t have the infrastructure to join the project.”

As a result, I18 observes a mixed picture of readiness, “it is a very mixed picture in terms of the readiness of operators from a behavioural, a business and a technical readiness to integrate into MaaS” (I18). Here, I16 clarifies that a split between legacy public transport providers and new mobility providers exists, “I would say for the traditional kind of bus operators and kind of trams and those older operators […], there’s a lot harder work because many of the systems are very aged” (I16). For I2, identifying the technically ready MSPs had been a significant issue.

Considering real-time information, Ghazy et al. (2021) introduce a data layer built on the infrastructure layer. Though, this layer is far away from reality. Evidence shows that real-time data would be a beautiful dream in most cases but requires a significant modernisation in the backends of participating actors (I2, I3, I5, I11, I13):

I2: (1) "we needed real-time data from usage. I can't do a minutes package if I don't have the real-time data […]. They would have had to change their entire backend in order to be able to map this live data."
(2) "the first thing you do is open the lock with Bluetooth. (company name) did not actually want to support this technology."

I3: "there was no one who had the API ready in that time, which was necessary for the deep integration."

I5: "it would be a beautiful dream if they all had APIs to which they could automatically share data […]. We're talking about XML, maybe Excel tables"

I11: "the problem was that they didn't have real-time data. And without real-time data, we didn't want to introduce them. Because if I plan a journey, then it gives you fake data which is not reliable."

I13: "we have one company that has existed already for 30 years and is now confronted with a MaaS market, and they don't have the investment ready […], it would need a complete overhaul of their whole backend."

Smith and Hensher (2020) recognise the technocratic nature of real-time information and their quality and report progress in projects. This is partly shared by I7, who reports an increase in players with interfaces, "I think a lot has happened in the last two years; I believe that there are now relatively many players who also provide these interfaces" (I7). Hasselwander and Bigotte (2022) also recognise this and see such ICT tools and technologies as essential, which would impede the MaaS implementation if unavailable. Significant barriers lie in integrating supporting technologies and ICT tools like Bluetooth, RFID and GPS. I2 reports that a lack of integration blocks deep integrations and is expensive.

(TD4) Unclear or No Platform Architectures Existing

TD4 represents barriers experienced concerning outdated IT infrastructure, IT systems and their respective architectures. The following table presents the evaluation of the cross-case results of this subtheme. After presenting the outcome, the empirical findings are detailed.

Table 31. Evaluation of Unclear or No Platform Architectures Existing

Purpose	*Characteristics from Literature*	*<u>Outcome</u>*
Unclear or No Platform Architectures Existing *Smith and Hensher (2020)* *This barrier's purpose concerns unclear or missing IT solutions or platform architectures.*	➢ Smith and Hensher (2020): Design of platform architectures in their technocratic context.	<u>Confirmation:</u> Findings confirmed that an underestimation of edge cases exists and that the design of platforms is crucial.
	➢ Reyes García et al. (2020): Lack of common architecture is causing complex integration.	<u>Amendment</u>: Participants report that they struggle with defining a consistent user experience and platform.
	➢ Zhou et al. (2023): Enterprise architecture modelling would help.	<u>Mixed Pattern</u>: Enterprise architecture would help, but it is not their bread and butter to architect such platforms for the participants.
	➢ Yano et al. (2022): An increasing shift towards cloud solutions.	<u>Amendment</u>: Infrastructure is still hosted on-premises, and there is little experience with cloud platforms.
<u>Conclusion:</u> *Participants recognise that many edge cases increase the complexity of MaaS. MaaS architecture is not where it should be. Enterprise modelling and typical architecture can help to increase consistency across the MaaS solutions.*		

In its academic context, Smith and Hensher (2020) describe this barrier in the context of its technocratic nature with platform architectures. The findings of this thesis revealed that it is indeed a challenge how MaaS platforms and the technology are being architected. I8 mentions an underestimation of the number of edge cases, indicating the complexity of MaaS, “one challenge has been how you architect your technology […]. It was a matter of the maturity of the MaaS platform tech. It was an under-estimation of the number of edge cases in mobility” (I8).

This complexity is also recognised by Reyes García et al. (2020), who outlined that the number of MaaS providers is caused by a lack of common architecture that facilitates the complex integration of all actors involved in the MaaS ecosystem. According to I7, defining a MaaS platform and creating a consistent user experience was one of the main aspects, “clearly define a platform, what it should be able to do, what it should look like and that it should create as uniform a user experience as possible” (I7). The architecture had not been up to the standard where they wanted it to be, “we have an app, but it is not up to the standard of where we want it to be. And, those partners are, it’s not their bread and butter” (I10).

In the academic literature, *Zhou et al. (2023)* contend that because of the complexity, a connection with enterprise architecture modelling would help to address resilience concerns for MaaS reliability. While this cannot be proven with the case studies, it is evident that better modelling would help. I5 highlights that creating consistency across different MaaS solutions can be important, “we do have the data, but it’s not available on an open source API, or we don’t have the ability to share that with the national body” (I5). In this context, it is also evident that for many actors in the MaaS ecosystem, it is not their “bread and butter” (I10) to architect and further develop such platforms.

I16 recognises a shift from traditional architecture towards a more cloud-based approach for MaaS, “traditionally, you know you would have an IT team that will look after these systems as a whole, but increasingly these are cloud-based services“ (I16). Yano et al. (2022) also recognise this shift and propose and implement a MaaS system architecture for inducing users to solve social issues using cloud services. In conclusion, the findings suggest a move towards more flexible, scalable, cost-effective solutions and a move away from traditional IT systems.

(TD+) Inductive Codes

During the analysis of the cases, four more codes around technology and data emerged, *Accuracy of Data, Flexibility of Existing Commercial Solutions, Integration Efforts* and *Manual Processes Not Digitised.* The findings of these inductive codes will be compared to the findings of *TD1-TD4.*

Accuracy of Data

The code accuracy of data can be mapped back to TD2 and extends the barrier of having real-time data towards the quality of public transport information. From the findings, it became clear that data accuracy is needed to provide accurate routing information and test the new services' functionality. I2 states that "we had to test the routing, test locations, before we went live" (I2), emphasising the need for accurate data. In addition to this point, I11 mentions that having accurate data is critical because otherwise, the system "would give you fake data which is not reliable" (I11).

Both points emphasise the importance of accurate and reliable data for a MaaS platform's success. Further, the accuracy of data affects the user's trust in being provided with correct data and thus directly impacts the platform's adoption and usage.

The Flexibility of Existing Commercial Solutions

The evidence showed that the MaaS providers sometimes decided against commercial solutions as they were not flexible enough for implementation. For example, I1 mentions that “they were unable to offer individual components” (I1), lacking a frontend solution and already had other backend services. In comparison, I12, for example, had their ticketing and routing system in place and searched for “what we call the MaaS layer” (I12).

Other interviews report the same, highlighting that they were instead developing their solutions than buying them from the commercial there because they want to operate and change the solutions if needed, “we want to keep them in our hands so we can operate; so we can handle it, we can change it; we can update it. So that’s the reason why we are developing and don’t buy it from the commercial sphere like other cities” (I14). I15 adds, “lots of the suppliers can address 80% of our requirements, but no one’s got the full solution. We are not just looking to buy MaaS technology but a partner who can do the integration for us as well” (I15). This is also shared by I18, who states, “we found that most of the providers in the market, if not all of them, couldn’t deliver everything we wanted” (I18).

Still, the interviewed cases are looking for a technology partner who can do the implementation together with them. Some collaborative proposals were observed here because the providers discovered that “they could not deliver it alone” (I18).

Overall, this code points out that the cases are experiencing a barrier to finding flexible commercial solutions for MaaS that meet their requirements and let them control the solution. As a result, most of them started developing their own solutions that are likely unsuitable for standardisation and data openness (TD2).

Integration Efforts

This code can be related to TD2, TD3 and TD4. Also, in literature, this has been observed as a barrier by Hensher and Xi (2022), who state that the real MaaS challenge is to design an offer that aligns the effort level with the seamlessness that matters to an individual. This code is primarily represented in the data corpus. Many actors see the integration as a complex and costly process that may not bring immediate returns for the actors involved, “they see that integration is hard. It will cost a lot of money and time, and they don’t see the profits, but we see the profits” (I14). This is also caused by the missing standard and the fact that each integration is unique and requires a significant amount of work and collaboration (I11, I18). These efforts encompass technical, legal, and time investments for various actors (I18).

I11: “it seems that I cannot do one type of integration, and then all the others can join easily. Every single integration will be different, and you must work with them a lot.”

I18: “they will have their costs to integrate, whether it’s technical costs for developers on their side, whether it’s legal costs for the commercial deal, or just time from their business to attend meetings and participate.”

For example, I8 mentions that sometimes the integration process takes nine months or more. I10 reported the need for enough resources to be available. Interviewed cases in the pilot stage faced added challenges in persuading others to join due to extensive integration efforts required (I13). Some decision-makers underestimated this effort, thinking that “an API connection costs nothing and is fast” (I7). However, the reality revealed that such an integration is always associated with many efforts. As a result, it becomes clear that there is a need for careful consideration and planning regarding the integration process of MaaS solutions.

Manual Processes Not Digitised

The last code that emerged from the findings is about processes that are not automated or digitised. In detail, the findings reported that the MaaS provider faced several challenges related to a manual process that should ideally be automated (I2, I3). Two challenges are the manual extraction of trips using Excel for accounting purposes and the manual process of selling subscriptions (I2, I3).

In this context, smaller actors relied heavily on manual processes, such as checking IDs and writing down identification data (I14). In addition, it was reported that some MSPs were technically unable to bill the MaaS provider with the desired pricing model, resulting in manual reporting and billing (I3). Another challenge was the lack of intelligent digital ticketing systems in some cities, which made it necessary to move to a digital system (I11, I12, I18).

I2: "what we did manually, for example, although it was promised otherwise despite the deep integration, was the accounting. This meant that someone at the office had to manually extract all the journeys via Excel and then invoice the MSPs."

I3: "but the subscriptions, if he didn't have one, we couldn't sell via the interface. That was a manual process in our back office. Another challenge with the MSPs was that no MSP was technically able to bill us with our pricing model. The problem was that the MSPs can't seem to do individual pricing models."

I11: "and the third thing is some digital ticketing […], there were no digital tickets till 2019."

I14: "the small car-sharing companies have a very simple mobile app. They have employees who sit there and check their faces and ID."

I18: "we don't have a smart ticketing solution."

5.3.2 Evaluating Barriers to Social and Cultural

The theme ***Social and* Cultural *(SC)*** is consisting out of six subthemes (SC1) A*c-ceptance of users, Travel Behaviour and Lack of User Trust*, (SC2) *Competition, Losing Monopoly Position, Control and Influence*, (SC3) *Difficulties for Users Related to Technologies, (SC4) Missing Collaboration, (SC5) Missing Leadership and Vision and (SC6) Skills and Knowledge Gaps.*

(SC1) Acceptance of Users, Travel Behaviour and Lack of User Trust

SC1 showcases the barriers to user acceptance, the required behaviour changes in travel behaviour and the lack of user trust. The following table presents the evaluation of the cross-case results of this subtheme.

Table 32. Evaluation of Acceptance of Users, Travel Behaviour and Lack of User Trust

Purpose	*Characteristics from Literature*	*Outcome*
Acceptance of Users, Travel Behaviour and Lack of User Trust *Karlsson (2020)* *This barrier's purpose is about acceptance of the users, their behaviour or lack of trust.*	➢ Alonso-González et al. (2017): The more services offered the better the user acceptance.	Amendment: Discovery of critical mass. MaaS becomes successful when reaching the critical mass.
	➢ Toyama (2022): Price value of the offering has an effect on adoption.	Confirmation: Participants report that price value is an important factor for them.
	➢ Polydoropoulou, Pagoni, Tsirimpa, et al. (2020): Need to aquire a deeper understanding of the key actor's motives.	Amendment: It is not just the persona; it is the lifestyle of everyone around that person.
	➢ Valkovic et al. (2021): Strong reputation and branding to increase user acceptance.	Amendment: Findings confirm reputation and branding to be critical. Offering the platform under an established brand increases acceptance.

	➢ Kandanaarachchi et al. (2022): Trust and collaboration framework.	Contradiction: An official stamp, “Certified MaaS Provider”, through a certification process would help more than a trust and collaboration framework.
Conclusion: *Participants see the requirements of having a critical mass crucial for accepting MaaS. In addition, the findings show that a change of habits and societal aspects need to be considered when building a MaaS platform. The participants suggest branding and reputation to overcome this barrier.*		

Evidence from the case studies revealed that there has been a low acceptance and demand, particularly in the pilot phases (I2, I7). Significantly, the "demand for subscription-based services was far below expectations and disappointing" (I2). The reason was that the app and solution did not incorporate all mobility providers. As a result, having a critical mass in the platform is an essential factor for the users' acceptance (I7). While this critical mass is a new factor, the literature reports that MaaS has to offer a higher level of multimodal integration to trigger noticeable changes in the users' travel behaviours (Karlsson, 2020). Alonso-González et al. (2017) recognise that more services offered can reduce those initial barriers.

Further, it was observed that people in the region "were not ready for that model yet, and it came across as quite expensive" (I10). This readiness has been also discussed in the academic literature. For example, in the work of Kamargianni and Goulding (2018), they construct a MaaS index for the cities' readiness and include citizen familiarity and willingness as a factor. Also, the price factor mentioned by I10 is a critical aspect, as the findings of Toyama (2022) show that the price value significantly affects the intention to use MaaS.

From a behavioural standpoint, it is a complex challenge requiring consideration of both technological and societal factors. I4 recognises that “there are people behind the users […], we need to change the habits, and it won’t be a quick change. I think when you give some service, and it fits into your needs, people will use it” (I4). Another behaviour aspect noted is the contrast between younger generations in cities, who no longer own or drive cars, and the older generation, including decision-makers, who grew up with car ownership, “especially Generation Z, many no longer drive a car, […], but people in a city council are mostly older people who grew up without it, so this whole sharing economy - there is a rethinking that has to take place there” (I3).

This barrier aligns with Polydoropoulou, Pagoni, Tsirimpa, et al. (2020), claiming that the success is to acquire a deeper understanding of the critical actors' motives and that particularly the firm reliance of people on their private vehicles was indicated as the most substantial social barrier. This research shows that the barriers to MaaS are "a behavioural and societal challenge more than a mobility challenge. So, I think if we're going to make this move happen, the state should create and support the environment" (I8). In this context, findings suggest that behaviour depends not only on the individual but also on the lifestyle of those around them, "we started to identify that it's not necessarily a person's lifestyle or that particular persona, but it's actually the lifestyle of everyone around that immediate person" (I16). This result shows that MaaS alone is not enough to drive such behaviour change.

To start this mind shift, it becomes essential to educate and sensitise people about the different mobility options:

"MaaS alone and technology alone in isolation will not create behavioural change. And it is very important to be able to teach people, educate people, sensitise people on different ways of transport" (I17).

Besides the behaviour perspective, findings indicate that the lack of user trust can hinder a successful MaaS platform. From an academic perspective, Valkovic et al. (2021) report that trust, especially a strong reputation and branding across their services, is key for a successful implementation. In this context, the previously described barrier TD1 (data security and privacy) plays an essential factor for a user to trust that the platform is protecting the customer data. The interviews show transparency rules in handling such data are critical, "in the end, certain transparency rules must be clear so that our customers, who also rely on our brand, know what happens to their data, or that when they give it to us and then indirectly to our affiliated partners, that there is no malpractice" (I1). This trust is also established through reliance on brands. During the pilot stages of the cases, it was found that creating such a brand can take longer than it seems at first glance, "a new brand takes time, a one-year pilot is far too short. It takes three to four years, especially if you want to change the modal split of the car owner" (I2). Here, the MaaS provider struggled to create a new brand identity if users did not associate it with established public transport operators: "what was difficult was that we appeared with a completely different name. So, it was also difficult to win customers for this platform, for this solution, if you can't advertise it in a big way, with the names of the municipal transport companies" (I3).

In relation to this, during the market research, some users had concerns about whether they would have problems with the platform. Kandanaarachchi et al. (2022) propose a theoretical framework for trust and collaboration in the literature.

However, in practice, an official stamp boosted user trust and reduced concerns, "some users are afraid if there will be any financial issues, like I don't get back my money or something like this. If there's a (name of provider) stamp on it, it can help users to trust better these companies" (I11).

(SC2) Competition, Losing Monopoly Position, Control, and Influence

SC2 is a social barrier addressing the competition, the fear of losing monopoly position or power of control and influence. The following table presents the evaluation of the cross-case results of this subtheme.

Table 33. Evaluation of Competition, Losing Monopoly Position, Control, and Influence

Purpose	*Characteristics from Literature*	*Outcome*
Competition, Losing Monopoly Position, Control and Influence *Alyavina et al. (2022)* *This barrier's purpose is about competition and losing power positions in the MaaS business ecosystem.*	➢ Karlsson et al. (2017): Cooperation needed, regional and local actors are key.	Amendment: Evidence shows that competition remains a major obstacle in the transportation sector.
	➢ Alyavina et al. (2022): Fear of losing power positions.	Amendment: Companies are afraid of cannibalising their own app and must balance between new customers and the risk of competition.
	➢ Arias-Molinares and García-Palomares (2020): Fairness must be an essential factor in the ecosystem.	Amendment: Initiatives like committees or boards are observed to ensure fairness.
Conclusion: *Participants report that competition exists between the market participants and transport companies. They fear losing control over their brand and thus cannibalising their offerings. To overcome that, fair competition and regulation will be the key.*		

In the literature, this barrier was recognised early on as a prerequisite for good co-operation, as the regional and local actors are permeated by both formal and informal institutions (Karlsson et al., 2017). The results show that competition is still a major obstacle in the transport sector. The participants of the study stressed that in their experience, there is commercial competition between market participants because transport companies are afraid of losing customers. (I2, I6, I13):

I2: "we had already noticed this competition […]. And it's also quite opportune, so I mean, competition doesn't always hurt."

I6: "public transit scenes have been seeing them as enemies, competitors."

I13: "there already is commercial competition between market parties […]. A lot of transport operators are, of course, afraid we are competing with the same customer."

However, smaller MaaS platforms report that they feel the other players do not need them and therefore do not see them as competition, "they don't see us as competition. They will see us like they don't need us" (I14).

Still, competition remains a significant barrier for the interviewed cases. The results show that transport companies tend to keep certain information about their bus routes in their own app because they fear losing users of their own app, "they'll keep the best information, like where specifically the bus route is on their route, for their own app because they want to attract customers to their own app" (I5). In literature, Alyavina et al. (2022) findings show that the fear of loss of control over their own brand is the reason for such behaviour. It turns out that the participating companies are mainly afraid of cannibalising their own app (I5, I7). They might also target other audiences and pay commissions, losing control and power over their own app and mobile offering (I7, I11).

I5: "as part of that business case consideration, they will be cannibalising their own app usage."

I7: "until this idea has manifested itself, that I'm not cannibalising my own offering here, but simply addressing another target group, I think that's always the biggest hurdle."

I11: "they might not want to introduce their system into our application, because they must pay commissions. And they are afraid that their application won't be used anymore."

Another factor that affects competition is the political factor. I12 reports that "it is a question of visibility [...] and a question of power and position" (I12). For example, some decision-makers fear losing their position of power if they open their offers to other actors, "there is still nervousness about how it will impact patronage on my mode […] and a bit of I want to keep control of myself, of my piece […]. We are going to push all things equally" (I10). There is also a tendency to see opening up as risky because it increases competition (I16). As a result, a trade-off arises between the potential to attract new customers and the risk of increased competition by opening up to a MaaS platform provider.

The key will be establishing fair competition and regulation for an open MaaS ecosystem. This is also desired by the participants in this study, who stress that "we have tried to make it clear to operators that we will be fair in terms of competition" (I18). This aligns with the findings of Arias-Molinares and García-Palomares (2020), who emphasise that fairness is essential to the ecosystem. First initiatives in the ecosystem are also observed. For example, I6 started "to set up some kind of committee or board with MSPs to discuss different ideas" (I6).

(SC3) Difficulties for Users Related to Technologies

The barrier SC3 addresses the difficulty for users to understand and effectively use the MaaS technologies, due to missing know-how or other factors. The following table presents the evaluation of the cross-case results of this subtheme.

Table 34. Evaluation of Difficulties for Users Related to Technologies

<table>
<tr><td>Purpose</td><td>Characteristics from Literature</td><td><u>Outcome</u></td></tr>
<tr><td rowspan="3">Difficulties for Users Related to Technologies
Arias-Molinares and García-Palomares (2020)

This barrier's purpose is about technological issues for the users to understand and effectively use MaaS.</td><td>➢ Arias-Molinares and García-Palomares (2020): Difficulty to navigate through all MaaS information and technology.</td><td><u>Confirmation:</u> Findings report that a general understanding of MaaS is not the problem but rather a technical understanding.</td></tr>
<tr><td>➢ Alonso-González et al. (2017): The MaaS users are not ready yet.</td><td><u>Amendment:</u> MaaS providers try to simplify the accessibility to their services and awareness-raising campaigns.</td></tr>
<tr><td>➢ Smith et al. (2022): Long-term analyses of MaaS adoption needed.</td><td><u>Confirmation:</u> Long-term analyses targeted at representative populations are needed.</td></tr>
<tr><td colspan="3"><u>Confirmation:</u>
Participants report that understanding MaaS is not the problem but rather understanding the technical concept. To lower the barriers, they developed a single-sign-on to their app. To overcome this barrier awareness-raising campaigns are suggested.</td></tr>
</table>

The paper of Arias-Molinares and García-Palomares (2020) shows that with the options through MaaS increasing, users find it challenging to navigate through all the information sources, applications, tickets and journey planners. While MaaS tries to counter these effects by providing a unified experience, it is evident that some user groups will still have issues using the technology.

This is supported by the findings of this work, as participants describe that a general understanding of MaaS is often not the problem but rather a technical understanding of the concept, “I think that a general understanding of a more modal application is not the big problem in terms of understanding, but rather in terms of technical understanding. I believe that many people were not yet ready to integrate themselves directly” (I7). This leads to low barriers to adoption as there is “a proportion of the population that will not ever use an app, and they’re a proportion of the population that uses apps all the time” (I8).

However, this contrasts to the findings of Alonso-González et al. (2017), who see user readiness as the main factor. Empirical evidence shows that most users do not know how to use such a concept. MaaS providers try to lower this barrier by providing users with a single login for all services. For example, if a user had already registered for a previous non-integrated offering, they can be hinted that they can use the same login procedures to use the MaaS platform, “we say that our customers only have to enter the relevant data once and then they can use all your services. Of course, they can also use the services of others. But in this way, I simply increase the overall customer potential for the different providers” (I1). In addition to the end-user perspective, it is pointed out that some actors in the ecosystem are not used to paying commissions or transaction fees (I18). Therefore, they do not understand the concept of MaaS and how it could benefit their business. This is also due to the fact that many of their internal staff have never heard of the concept of MaaS (I18). This highlights the importance of training and awareness-raising campaigns to help them understand the concept and its benefits.

I18: (1) "and bus operators aren't used to working in that way. They're also not used to paying commission or paying for financial transaction costs. It's why we started so early on this path of 12 to 18 months ago, engaging them so that they could understand and, in some cases, learn what MaaS was and understand what benefit it could potentially bring to their business." (2) "you know, it's not a big sell in terms of what the idea of it is on the concept. But with a lot of the people internally, they've never heard of MaaS."

It can be concluded that there are some challenges in the adoption and diffusion of MaaS technology caused by a still limited understanding of the technology among users and by parts of the population that do not use multiple apps on a regular basis. In this context, Smith et al. (2022) also emphasise the need for long-term analyses of MaaS service adoption targeted at representative populations.

(SC4) Missing Collaboration

SC4 addresses missing collaboration between the different actors in the MaaS business ecosystem. The following table presents the evaluation of the cross-case results of this subtheme.

Table 35. Evaluation of Missing Collaboration

Purpose	*Characteristics from Literature*	*Outcome*
Missing Collaboration *Smith et al. (2019)* *This barrier is about missing collaboration between the actors in the MaaS business ecosystem.*	➢ Smith et al. (2019): Innovation process of MaaS goes hand in hand with inter-organisational collaboration.	Confirmation: Collaboration is seen by the participants as one of the most important factors.
	➢ Karlsson et al. (2020): Lack of cultures of collaboration and assumed roles and responsibilities.	Amendment: Participants report that a culture of no collaboration is caused by missing know-how on developing MaaS solutions.

<table>
<tr><td></td><td>➢ Arias-Molinares and García-Palomares (2020): opposing objectives in private and public organisations are triggering collaboration barriers.</td><td><u>Contradiction:</u> While opposing objectives might be one reason, it is reported that talking to some involved parties is politically sensitive.</td></tr>
<tr><td colspan="3"><u>Conclusion:</u>
Participants report that key decision makers do not exchange on MaaS platforms regularly and that it is sometimes politically sensitive to talk about it.</td></tr>
</table>

Early in the literature, Smith et al. (2019) argued that the innovation process of MaaS goes hand in hand with increased inter-organisational collaboration and that barriers will originate from this process, making it difficult for public providers to collaborate with private actors. This has also been reflected by the findings of this study, showing that cooperation and collaboration in the MaaS ecosystem are hampered for several reasons.

One factor observed is that no culture of collaboration or cooperation exists, also caused by missing know-how on developing solutions together. I4 states, “so there is no culture of working together or cooperation or developing services together, and there is not this kind of culture. There is also no know-how on how to create these solutions together” (I4). One reason for that is outlined by Karlsson et al. (2020), explaining that there is a lack of cultures of collaboration and assumed roles and responsibilities in the MaaS business ecosystem existing. Also, informal factors such as organisational cultures, new collaboration, and partnerships are established among actors who have not previously worked together.

Another observed factor is that some stakeholders do not talk to each other. I2 reports, “politicians, for example the executive, also the transport ministers of the three cities, have never talked to each other about this topic” (I2).

This led to an unwillingness to give their budget for the benefit of others, “these are all different ministries, different people involved, and different funding; they don’t talk together and perhaps even if they do, it’s their own budget, and they are not very willing to give away their own budgets for the benefit of others” (I13).

In this context, it was also reported that it is not easy to get in touch with some actors “we haven’t talked with the biggest providers […], because it’s hard to get in touch with them” (I14). Sometimes it was even politically sensitive to talk directly to the companies, “operators are a very sensitive, politically sensitive space, so I do not speak to them directly unless one speaks to me” (I15). This aligns with the findings of Arias-Molinares and García-Palomares (2020), who argue that opposing objectives in private and public organisations may create barriers to collaboration.

Overall, the evidence revealed that the MaaS provider and other actors are confronted with many barriers that make cooperation and collaboration difficult. It is necessary to overcome these barriers to cooperate successfully and develop solutions.

(SC5) Missing Leadership and Vision

SC5 is a barrier which emerged by a lack of a future vision and leadership among the MaaS business ecosystem actors. The following table presents the evaluation of the cross-case results of this subtheme. After presenting the outcome, the empirical findings are detailed.

Table 36. Evaluation of Missing Leadership and Vision

Purpose	*Characteristics from Literature*	*Outcome*
Missing Leadership and Vision *Guyader et al. (2021)* *This barrier is about missing leadership and vision between the actors in the MaaS business ecosystem.*	➢ Guyader et al. (2021): Leadership involvement to manage and resolve tensions in the ecosystem.	Contradiction: There is a lack of general leadership involvement observed. In addition, taking the lead can be dangerous.
	➢ Mulley and Nelson (2020); Smith and Hensher (2020): Establishment of MaaS champions. ➢ Kandanaarachchi et al. (2022): MaaS champions and mix of partners.	Confirmation: Findings show that the establishment of MaaS champions is crucial for success.
	➢ Valkovic et al. (2021): Mismatch between mode share targets and investments.	Amendment: Participants are missing guidance on what their role is.
	➢ Meurs et al. (2020): Formation of MaaS alliances.	Confirmation: Participants are part of MaaS alliances.
Conclusion: *Participants report that a lack of leadership exists across the cases. Public sector organisations reported slow decision-making and an uphill battle against traditional mindsets. The first pilots' findings help the cities think about the mobility strategy. Having a MaaS champion is crucial for a successful MaaS platform.*		

Guyader et al. (2021) recognise that leadership involvement in managing and resolving tensions in MaaS ecosystems is critical. This study's findings indicate a lack of leadership across the cases. Namely, a lack of clear accountability and leadership at the city, regional and state level are observed, “I think there is a lack of general leadership at the city, regional and state levels in terms of mobility” (I8). Evidence shows that “taking the lead can be very dangerous” (I12).

One reason for that was that decision-making in public sector organisations had been reported as slow and involved an uphill battle against traditional mindsets and forms of organisation (I15). Further, it has been reported that too many people are involved in decision-making (I15).

I15: (1) “I equate it to like when 10-year-olds play football; everyone’s chasing the ball. It’s that lack of clear accountability, like who’s responsible for business outcomes. It’s so slow.”

(2) “it’s not necessarily always supported by my colleagues or leadership, so it’s an uphill battle to sometimes bring us around. The slowness of the public sector, like the number of people that need to be involved in every decision.”

(3) “we don’t really have someone championing or expanding shared mobility.”

This highlights the need for a person to be committed to making MaaS a success in the region. Scholars have also recognised this, introducing the MaaS champion actor. This actor takes a strong leadership role by combining short-term innovation with the development of long-term sustainability visions linked to societal change (Mulley & Nelson, 2020; Smith & Hensher, 2020).

However, not all participants observed a lack of MaaS champions. For example, I18 reports that “the political and senior leadership side, have helped to bring other stakeholders along that journey and convince them that this is the right things for us to be doing” (I18). Such findings are confirmed by Kandanaarachchi et al. (2022), who report from the Sydney MaaS trial that having a MaaS champion and the right mix of partners has been a crucial factor for success.

Nevertheless, participants stated that a verbal exchange between senior policymakers and transport ministers was achieved through the success of some MaaS platforms in the investigated city.

With the results of the pilots, they were forced to think about a mobility strategy beyond their own cities (I2). It is clear that the operators need such support and guidance to create successful MaaS platforms (I4).

I2: *"we got them, or forced them, to think about a mobility strategy for the city […]. Creating an exchange among the three cities, the politicians, i.e. the executive, also the transport ministers of the three cities, who have never talked about this topic with each other."*

I4: *"the operators need more help. At least guidance on what they need to do, what their role is and like helping operators think this can be done some other way."*

These findings align with Valkovic et al. (2021), who recognise that while strategic objectives exist in city master plans, there is often a mismatch between mode share targets and the investments needed to achieve them. Dependent on the individual cities, Meurs et al. (2020) suggest the formation of MaaS alliances, helping to bring together MaaS champions.

(SC6) Skills and Knowledge Gaps

SC6 describes the barrier that the MaaS provider lacks skills or has knowledge gaps required to build a MaaS platform. The following table presents the evaluation of the cross-case results of this subtheme.

Table 37. Evaluation of Skills and Knowledge Gaps

Purpose	*Characteristics from Literature*	Outcome
Skills and Knowledge Gaps *Crozet and Coldefy (2021)*	➢ Crozet and Coldefy (2021): New skills are required to position as a trusted third party.	Amendment: Participants report that know-how and resources are missing to develop technical MaaS solutions.

<table>
<tr><td rowspan="2">This barrier is about missing skills and knowledge among the actors in the MaaS business ecosystem.</td><td>➢ Kayikci and Kabadurmus (2022): Labour shortage on skilled people.</td><td><u>Amendment:</u> Recruitment processes are not tailored to these skills; public companies are confronted with new competencies that may not have previously needed.</td></tr>
<tr><td>➢ Smith and Hensher (2020): Senior leadership lacks digitalisation skills.</td><td><u>Amendment:</u> The lack of senior leadership skills requires the public MaaS provider to rely on third parties and consultancies.</td></tr>
<tr><td colspan="3"><u>Conclusion:</u>
Participants report that they lack the resources and know-how to build MaaS platforms. Further, they report that the labour shortage is caused by funding and attracting new talent. They recognise that they need to build up their in-house IT capabilities.</td></tr>
</table>

In literature, Crozet and Coldefy (2021) stress that the MaaS provider has to acquire new skills and position themselves as a trusted third party. These missing skills are also represented in the empirical data collected by this thesis. For example, participants describe a lack of resources and skills to develop and implement a successful MaaS platform (I2, I4, I5, I12):

I2: *"(providers) have neither the resources nor the know-how to do anything with them."*

I4: *"there is no model of acting like this, so they have had this public task, and it's been done in the same way for four decades."*

I5: *"they probably don't have the capability, but they don't have they don't have app developers, and backend API connectors and things like that."*

I12: *"there is a question of skills. There is a fundamental question of skills and organisation […]. it's going to be a challenge for (the providers) and many companies that want to do that."*

Here, it is pointed out that the MaaS provider does not have the necessary resources to properly develop the MaaS offering, including financial and technical know-how. In this context, significant knowledge gaps exist as some MaaS providers have no vision and lag in digitalisation and technology, "we're not used to having digital products that are trying to compete with some huge players. So, we must learn quickly in that area and leverage the technology providers […]. There is quite a skill shortage. But I think those skills are constantly growing, and it's more about behaviours." (I10). Such skills include app development and technical know-how to develop interfaces and backends.

In addition, I9 mentions that public MaaS provider companies often do not have their own development, resulting in the company relying on external support and not having the technical capacity to do the integration work. That is being caused because their traditional business has been providing transportation infrastructure, and now, they are confronted with competencies they may not have previously needed. For this, I9 states that the company would prefer specific recruitment processes to be more tailored to these new skills, suggesting a shortage of skilled workers exists. This barrier to labour shortage has also been highlighted by Kayikci and Kabadurmus (2022).

I9: *(1) "we don't do the technical integration work, but the technical work is done by our platform partner, who provides the technical platform. We don't have any developers with us, but of course it is also a control effort for us."*

(2) "classic providers, providers like us who actually have a classic brick and mortar business or a strong infrastructure business, are simply confronted with competencies that they may not have needed in the past."

(3) "we would like certain recruitment processes […], to be more tailored to us. We are 22 people out of 16,000, […] we play an exotic role."

In the end, the labour shortage indicates that money and funding play an essential role in attracting new talent “it is just about money. Do they have enough funding or income to spend on attracting new development and developers?” (I13). If a public MaaS provider has enough funds, the company can attract new technical people and developers. In one case of this study, the MaaS provider stated, “we have a small developer team […]. Our director thinks it’s bigger. We can build that in a month. They’re already busy, but we did our own website” (I15).

This shows that senior leadership lacks the digitisation skills required to make a MaaS platform a success. Here, lacking a shared language could hamper knowledge exchange Smith and Hensher (2020). In another case, the public MaaS provider relies on many agencies and consultants. Here, I18 thinks that this will not be the right approach in the longer term and that public companies need to keep their expertise in-house and develop their own digital capabilities instead of relying on consultants to do the work for them “in the short term, many authorities will rely on consultants to deliver some of that for them. But you know, I don’t think that’s the right approach in the long term because if they want to deliver this, they should do it in-house, retain the expertise in-house, and develop the relationships internally rather than paying consultants to do it for them” (I18).

(SC+) Inductive Codes

Besides the codes, SC1-SC6, more inductive codes have emerged from the findings. These SC+ inductive codes are *Inclusion Agenda, Multiple Existing Apps,* and *Prioritisation*. They can be understood as an extension of the deductive codes.

Inclusion Agenda

The inclusion agenda has emerged as essential when developing a MaaS platform. Inclusion in the context of a MaaS platform refers to ensuring that all users' mobility needs are met, and that the platform is accessible to all groups of users. The evidence of the cases revealed that MaaS could be an opportunity to bring older people closer to these topics "I believe we have a great opportunity to bring older population groups closer to these topics" (I1). Moreover, when developing a MaaS platform, user-friendliness, accessibility, and affordability should be prioritised (I8, I10).

I8: *“you could create an app for people on low income and provide people on a low income with better public transit pricing than you do people on general income.”*

I10: *“I think in terms of affordability and pricing models, it’s an exciting space with MaaS because we’re all still learning.”*

At the same time, all common languages should be supported “the other thing that we have to do is make things available in a (specific) language, and commercial providers like Google Maps don’t support (this language)” (I15).

Participants also note that smaller areas and populations, especially more rural ones, should not be excluded from the platform “it is up to us to now identify how we can incorporate them so that no one is left out. At the end of the day, you don’t want to start serving the bigger areas and forget the smaller areas […]. It’s about inclusion […]. You don’t target an audience and leave another audience standing” (I17). Also, I5 states that “we don’t want to exclude them, nor do our clients want to exclude them from a MaaS ecosystem, just because they don’t have an API […]. Regional transport partnerships have a policy objective to be able to increase inclusion” (I5).

In conclusion, the points highlight that during the development and planning of a MaaS platform, special attention must be paid to ensure topics like inclusion. Through that, an inclusive platform can be created, which lowers other previously mentioned barriers.

Multiple Existing Apps

Another emerging barrier has been that multiple apps already existed, making it hard to get other actors or users interested. Findings showed that it could be challenging for users and providers as different apps to cover different mobility needs already exist. As MaaS aims to unify those experiences into one single app, it raises the question of how to manage the actors and users of existing apps. In the context of the cases, the participants describe this as a barrier as most of them already have apps available and are well-used (I7, I11, I15):

I7: "there was or is an existing transport application in (case name), as in most regions, which is also very well used and they did not design a new joint application, but wanted to provide a MaaS application in parallel […]. There was a controversial discussion in (case name) about whether it makes sense to have two apps next to each other."

I11: "we had an application called (application name), but it was only about journey planning […]. And we also make other applications. Another one was about actual information about public transport. So, all these players have their applications, which are quite good. So, will people use (our app)?"

I15: "so, we have four mobile apps today, we've been trying to play catch up with (competitor) […]. What I'm looking at is how we differentiate from (competitor) and offer a different value proposition."

More social questions arise here because the users might already use other applications that meet their needs. Here, I9 states, "we don't just want them to be in our app, but we also want the offer to be used via (our app). If the offer in (our app) is always weaker than in the native app, where will people use it then?" (I9).

The MaaS providers try to address that by having a clear and attractive value proposition to make users want to adopt and use the MaaS platform. In this context, the challenge is designing this value proposition to attract new customers to the platform and increase the existing users' loyalty. Thus, a clear strategy for the MaaS provider is required to position the MaaS platform among the other existing apps.

Prioritisation

The last barrier that emerged in this topic area is about prioritising different tasks or actors in the MaaS business ecosystem. Prioritisation is essential when developing the MaaS offering as it streamlines the project tasks that must be performed first. However, this is considered challenging, as many options exist for building and growing a MaaS platform. Therefore, with limited funding and resources, starting with the most critical tasks becomes increasingly essential. This has also been indicated by the participants of this study, highlighting this as a significant factor or issue in building a MaaS platform (I10, I15).

I10: “we have several things they must address daily, operationally, and new projects […]. Lots of projects are going on, and so sometimes we see conflicts. What is the priority?”

I15: “do we prioritise improvements to (our app), or do we prioritise improvements to make it multimodal?”

One example is the different strategic orientations or development goals of the participating actors or sometimes the provider itself “different players have different strategic orientations […]. All these providers have their own development goals. Perhaps there are other platforms into which they are to be integrated” (I9).

In this context, the provider needs to decide whether the platform should be limited to only public offers and expand on those or directly start to offer a wide range of transport modes “did we want to aim for just public transport and prioritise that, or have a range? Our customer engagement and lessons from other MaaS implementations elsewhere told us that having a range was more important […]. So, our priorities were the dominant transport providers and the providers that helped bring in additional modes and services” (I18).

Findings and research of those providers revealed that having a wider choice is required to make users want to adopt the platform. For this reason, most providers focused on the dominant MSPs in their region and then added micro-mobility step by step. This prioritisation strategy can also lead to conflicts and opposite objectives of all parties involved. Thus, effective prioritisation is important for a successful MaaS platform in a reasonable timeframe.

5.3.3 Evaluating Barriers to Policy and Regulation

The barrier theme ***Policy and Regulation (PR)*** is consisting out of three subthemes (PR1) *Demand Estimation, Creation of Business Models, Tailoring of Services, (PR2) Legal Issues, Bureaucracy, and Institutional Barriers* and *(PR3) Poor Governance Frameworks, Policy and Regulation Challenges.*

(PR1) Demand Estimation, Creation of Business Models, Tailoring of Services

PR1 describes the barriers experienced when estimating the demand, creating business models, and tailoring mobility services. The following table presents the evaluation of the cross-case results of this subtheme. After presenting the outcome, the empirical findings are detailed.

Table 38. Evaluation of Demand Estimation, Creation of Business Models, Tailoring of Services

Purpose	*Characteristics from Literature*	*Outcome*
Demand Estimation, Creation of Business Models, Tailoring of Services *Mulley and Nelson (2020)* *This barrier is about missing demand, business models and tailoring the services.*	➢ Mulley and Nelson (2020): Business model discussion is in an early stage, and educational elements need to be in the business plan.	Confirmation: MaaS providers struggle to establish a business plan.
	➢ Arias-Molinares and García-Palomares (2020): Tailoring MaaS also to B2B.	Confirmation: MaaS is subsidised; a sustainable business model needs to include B2B.
	➢ Turoń (2022): Readiness of business models using CANVAS.	Confirmation: Modelling with CANVAS would indicate gaps in business models.
Conclusion: *Participants report that they are challenged to establish a user base in cities and struggle to establish a business plan. Tailoring the services is often not possible due to local restrictions.*		

In this context, demand estimation refers to gathering information about the demand for mobility services. To ensure that the services offered to meet customers' needs, it is crucial to understand their needs and wants. Estimating such demand is challenging for a MaaS provider and is influenced by many factors. Evidence showed that establishing a MaaS model in some markets can be challenging as there are not enough large cities to generate a sufficient customer base (I3, I4).

I3: *“we simply don't have such big cities […]. That was also the challenge for us.”*

I4: *“in (case country) markets, for example, for MaaS providers and public transport operators, the country’s land area is quite big, so the market for potential users is quite small, and therefore, the operators would need a bigger market.”*

Further, it is indicated that many public transport operators do not understand what their customers need, while they are good at understanding how transportation works, “because if you go, if you went to a public transit agency and said, do you understand your customers? Most have no idea what they’d understand is operations of moving buses and trains” (I8).

Here, it is unclear which part of MaaS is the most important for the customer, just the multimodal journey planning or potentially other topics, “but one thing that we don’t know is, what do our customers really need? Do they really want a multimodal journey planner?” (I15).

Through this lack of understanding of the user, many MSPs are critical of public projects, as they are not generating the expected demand “the suppliers are getting tired; there have been so many city projects with different technology platforms, and they haven’t created the demand that there was hoped” (I8).

This highlights the importance of developing a deep understanding of the users before starting to implement a platform, but also a continuous effort to understand what the users are asking for during the platform's operation.

Besides the demand estimation, creating business models was a barrier for the cases. In the context of a MaaS platform, a business model refers to the design of an approach that enables all participating actors to profit from the creation of mobility services. In the literature, Mulley and Nelson (2020) acknowledge that the business model discussion is at an early stage.

Here, Mulley and Nelson (2020) emphasise that a business plan must consider the costs and establish value. The empirical findings show that many MaaS providers struggle to establish a business plan (I1, I2, I5, I7, I14). Some providers even consider a business model utopia in the short and mid-term (I2).

I1: "they still have to look much more closely at the money, especially the sharing providers, and see what has established itself, where there is really a business model behind it and what is unprofitable in terms of operating costs."

I2: "instead of saying we see this as a distribution channel, we sponsor a bit, they wanted commissions instead […]. A business model, commercial, that the platform providers or we now earn money, was a utopia."

I5: "I think, as part of that business case consideration, they will be cannibalising their own app usage."

I7: "I think the business model was quickly lost and that's why not everyone can afford to set up such a platform, because I think it costs a lot of money."

I14: "I think the critical part is the business model because I see the technical challenges; we can handle it."

Another participant even concluded that “the business models have been proven not to work at the city level. Every single city project I have seen either ceased once the innovation funding has run out or is heavily subsidised by a public body” (I8). To overcome such a challenge, Arias-Molinares and García-Palomares (2020) suggest offering mobility services not only to end-users but also to other companies (B2B). Moreover, Mulley and Nelson (2020) suggest that including educational elements in the business plan can enhance understanding of cost comparisons and mobility choices. Still, the MaaS providers are swimming in the illusion, waiting to see whether a business model can be established over time “we’re willing to pay, to develop it and for a period of operation, and the goal is then, by the end of 2024, we will prove whether this model has benefits” (I18).

A particular business model issue was the tailoring of mobility services. Here, the tailoring of services refers to the adoption of mobility services to the users' needs by bundling those services and creating subscriptions. Evidence shows that the cases reported regulatory challenges to create such an offering because no cross-subsidisation of public transport fares could be done (I2, I12).

I2: “a public transport subscription was compulsory […]. This also made it clear that public transport would not cross-subsidise public transport fares. We will not be able to offer other tariffs for new customers […]. That was not possible, from a regulatory point of view.”

I12: “we are going to have problems with the tariffs. Which tariffs do we put in this new project? We are thinking about a flat price.”

Thus, to succeed in the future, it is essential to consider regulatory requirements and develop a pricing strategy to enable a business model and drive user demand. This aligns with the findings of Turoń (2022), who checks the readiness of different business models using CANVAS models.

(PR2) Legal Issues, Bureaucracy, and Institutional Barriers

PR2 is a barrier identified about legal issues and slow decisions due to bureaucracy and institutional barriers. The following table presents the evaluation of the cross-case results of this subtheme.

Table 39. Evaluation of Legal Issues, Bureaucracy, and Institutional Barriers

<table>
<tr><th>Purpose</th><th>Characteristics from Literature</th><th><u>Outcome</u></th></tr>
<tr><td rowspan="5">Legal Issues, Bureaucracy, and Institutional Barriers
Kamargianni and Matyas (2017)
This barrier concerns legal issues, slow decisions and institutional change required to make MaaS successful.</td><td>➢ Kamargianni and Matyas (2017): Need for MaaS providers to have legal agreements and frameworks in place.</td><td><u>Amendment:</u> MaaS providers are bound by municipal and international laws.</td></tr>
<tr><td>➢ Murati (2020): No harmonised legal framework existing.</td><td><u>Confirmation</u>: The digital legal framework was unclear for the participants.</td></tr>
<tr><td>➢ Pagoni et al. (2022): Existing EU legal and regulatory frameworks need to be revisited.</td><td><u>Confirmation:</u> The participants were not aware of the legal frameworks in the EU.</td></tr>
<tr><td>➢ Smith and Hensher (2020): Long-term objectives are needed to overcome institutional barriers.</td><td><u>Amendment</u>: The lobby of the automotive industry is strong, and politicians think in political cycles.</td></tr>
<tr><td>➢ Kivimaa and Rogge (2022): Short-term experimentation should inform long-term institutional change.</td><td><u>Amendment:</u> Short-term experimentation with pilots helps politicians to understand and buy into it.</td></tr>
<tr><td colspan="3"><u>Conclusion:</u>
Participants report that they are bound by municipal law and sometimes delayed by international laws. Further, the legal requirements are unclear, and political decisions influence the solution's success. Senior decision-makers, politicians and other teams must provide their buy-in to overcome this barrier.</td></tr>
</table>

Legal issues can emerge through the complex legal requirements required to make MaaS a reality. These could span from local and national to international laws, rules and regulations. Kamargianni and Matyas (2017) early on highlighted the need for a MaaS provider to have legal agreements and frameworks in place. The findings of this thesis outline that the public MaaS providers are bound by municipal law and that everything they do needs to have a direct link to the city for which they operate (I1, I11). They are also influenced by international laws influencing their selection process of service providers. For example, I1 indicated that because of the European Schrems II ruling, their project had been delayed because they had to ensure that their digital service provider followed this rule:

I1: *(1) "we are also bound by municipal law […], everything we do must have a relatively direct connection to (our city)."*

(2) "we also have another one in there with the EU […]. That kind of chopped up our schedule a bit with regard to the Schrems II ruling. The European level is extremely influential, especially with these types of legislation."

I11: *"for me, the ultimate goal will be always to focus on (the city). I'm not responsible of that other (city)."*

Further, Murati (2020) indicate that under EU law, there is no harmonised legal basis for multimodal passenger transport in EU law. This is in line with the findings of this study. The cases revealed that their digital regulatory framework had not been clear, resulting in ambiguities in how the company structure should be set up in order to comply with legal requirements, "the digital legal framework is not clear in our country […]. (Actors) must change the structure, the legal structure of the companies" (I12). Other political decisions influenced some parties, resulting in the MaaS platform components being split: "the previous plan was to create this system together, but our inner political decisions made it split" (I14).

This problem has been recognised by Pagoni et al. (2022), who reviewed existing EU legal and regulatory frameworks and pointed out the importance of revising those regulations.

Besides legal issues, barriers to building a MaaS platform involve bureaucracy and institutional barriers caused by permitting processes of the individual cities. Often, this takes much time and can slow down the implementation of the MaaS platform (Kamargianni & Matyas, 2017). This study's findings revealed that institutional barriers are experienced because some MaaS providers were not allowed to mix the subsidised business with the innovation budget, creating a challenge because they cannot work with some actors (I2). In this context, the subsidies for public transport were perceived as lower than for car use, and politicians who go against the automotive industry are seen as politically unacceptable: "the use of motor vehicles is subsidised […], public transport is less subsidised, there is a subsidy, but it's less subsidised […]. Politicians having a go against the motorist is not politically viable" (I8). Moreover, certain actors' involvement raised political and legal sensitivities (I2):

I2: *(1) "there must be no mixing of subsidised business with such innovation business."*

(2) "then there was the issue of (one actor) […]. A cooperation was politically extremely sensitive, there were social court proceedings with false self-employment."

In addition, licensing barriers for ticketing were observed, "there are accreditation barriers for selling tickets that you must go through. It's a lot of effort" (I15). As recognised by Smith and Hensher (2020), it becomes crucial that even if political cycles, individual interests and public pressure exist, the focus should be on long-term objectives to overcome institutional barriers.

The recent paper of Kivimaa and Rogge (2022) concludes that such policy dynamics should be influenced by short-term experimentation and long-term institutional change. The case studies revealed that legal and institutional barriers are essential in establishing a MaaS platform. This is underlined by I18, who states that "we must get senior decision-makers, politicians, commercial teams, IT, finance and legal teams to understand MaaS to approve and buy into it" (I18). These will be the ones who can remove bureaucratic, legal, and institutional barriers.

(PR3) Poor Governance Frameworks, Policy, and Regulation Challenges

The barrier PR3 extends PR2 and addresses the lack of governance frameworks and missing policies or regulations. The following table presents the evaluation of the cross-case results of this subtheme.

Table 40. Evaluation of Poor Governance Frameworks, Policy, and Regulation Challenges

Purpose	*Characteristics from Literature*	*Outcome*
Poor Governance Framework, Policy, and Regulation Challenges *Karlsson et al. (2017)* *This barrier is about poor governance frameworks and missing policies or regulations.*	➢ Karlsson et al. (2017): Need of macro and meso level frameworks.	Mixed Pattern: Insufficient frameworks and different regulatory regimes were causing barriers to develop MaaS. The problem lies in formulating those frameworks.
	➢ Tabascio and Brail (2022): Need for governments to better understand the local and regional implications.	Mixed Pattern: Cities have little regulative power for MaaS. Inconsistent regulations across Europe make it difficult to formulate policies.
	➢ Mulley and Nelson (2020): Fairness and level playing fields.	Confirmation: Fairness and a level playing field are important.

	➢ Haavisto and Mladenović (2020): Regulation should not be the starting point for cooperation.	Confirmation: MaaS actors worked voluntarily because they saw value in cooperation.
	➢ Jittrapirom et al. (2020): Development of success criteria for cooperation.	Confirmation: Success criteria were seen as important for cooperation.
	➢ Arias-Molinares and García-Palomares (2020): Regulation can inhibit the ability of the private sector to participate and innovate.	Amendment: Participants report that too much regulation leads to unattractive MaaS, while too little towards high market volatility.
Conclusion: *Participants report insufficient governance frameworks, limited licensing options and different regulatory regimes. Further, they outline inconsistent regulation across Europe. While some participants wanted more regulation, others stressed the need not to over-regulate and called for flexible policy or regulation.*		

The lack of such frameworks poses challenges to the MaaS provider and their business ecosystem. In early literature, Karlsson et al. (2017) recognised the importance of such frameworks on a macro but also a meso level. In practice, different governance, policy, and regulations barriers were observed within the cases. Here, insufficient governance frameworks, limited licensing options and different regulatory regimes in different cities were causing barriers to a MaaS platform (I2, I6, I16):

I2: *“there were of course urban or local restrictions on our providers, i.e. the MSPs, via their business model […]. The city actually approves a lot of players, or has its thumb on a lot of players and decides there.”*

I6: *“for example, the city could have the authority to decide that all the mobility solutions should be registered […]. But there was no framework and not as authority delegated to the local government to enact such regulations.”*

I16: *“the regulation actually comes into play around regulating the rules of play when new modes come to a city.”*

In this context, Tabascio and Brail (2022) express the need for governments to better understand the local and regional implications. While some cities had the power to control licensing and the number of providers and vehicles, other cities' power was very limited to control the mobility options (I3, I14, I18). This shows that consistent regulation for MaaS is hard to achieve. With inconsistent regulations across Europe and little regulative power, it is hard for the MaaS providers to establish a clear framework and regulation (I14, I18).

I3: "it's the regulators in the cities […]. (One actor) has an exclusive licence for station-based bike sharing for three years. Furthermore, the number of vehicles is limited for e-scooter providers."

I13: "what makes it more difficult for us is that each city […], has had different permit regulations."

I14: "our regulations or laws can't allow the city to say you can't operate here, you can park the bikes here."

I18: "there is very little regulatory power, if any, to get them to participate within MaaS."

One particular aspect that would profit from regulation is ticketing. Findings report challenges for MaaS providers in combination with the commercial agreements (I5, I15). This is started to be addressed by a new EU regulation requiring public transport operators and private companies to open their ticketing (I15). Understanding what policy goal should be achieved has been a major challenge in combination with fairness (I16). Mulley and Nelson (2020) also emphasised this fairness and highlighted the need to create a level playing field. Such a field requires success criteria and cooperation between actors (Jittrapirom et al., 2020). However, regulation should not be the starting point for such cooperation, as it can cause many conflicts (Haavisto & Mladenović, 2020).

I5: "when bus operators win those contracts or run their own private services, if there are of a certain size, they have to provide their information with their routing information, their placing information, and their timetable information to a national service."

I15: (1) "In the EU, there is some new regulation coming in to make it so that all public transport operators must make their ticketing open."

(2) "that lack of regulation for open bus ticketing is a challenge, and that doesn't necessarily need to be techno-like mandating a certain technology or specification, but certainly, the revenue split-share agreements."

I16: "so, trying to understand what policy goal we're trying to achieve with MaaS has been quite a big challenge […]. That aspect of fair sharing and sharing the money between operators becomes challenging."

Besides wishing for regulation for specific areas, there is a concern that overly detailed legislation or regulation could also limit the development of MaaS platforms (I4, I5, I7). One example is that different member states and cities in the EU have their own legislation. If a regulation is formulated, it cannot be detailed because it cannot be applied everywhere (I4). This is also in line with the findings of Arias-Molinares and García-Palomares (2020), who report that too much regulation could inhibit the ability of the private sector to participate and innovate, leading to an unattractive MaaS, while too little regulation could lead to a failure to serve the public interest. As the 'product' of MaaS is still a learning process where things are constantly tried and re-evaluated, a framework needs to be flexible (I5). Thus, EU regulations are tried to be followed by the MaaS providers, but always keeping an eye on the political and legislative situation of the particular area (I7, I12). The following statements underline this:

I4: *"from the policy and legislative perspectives, it is very hard and would not work if the legislation is too detailed or legislates only one or two models […]. At the EU level, […], there are many different kinds of cities, and then we have rural areas, so the legislation cannot be too detailed."*

I5: *(1) "if there were legislation or, you know, even guidelines that said that's not a standard you're not really allowed to do, that might be prohibitive. I think with legislation and standards is that you need to be careful […]. not to preclude innovative ways of doing things because I don't think we've cracked MaaS yet […]. It could be a double-edged sword."*

(2) "it's such a fast-moving learning process in developing MaaS, and we try things, and we fail, and we try things, and they work, and I don't think we know all the things that work and don't work."

I7: *"the regulations that are based on the rules that have been set up in an area are also hurdles under certain circumstances."*

I12: *"if you bought an electric vehicle four years ago, you have three different plugs to do that. That makes no sense. We try to avoid this problem."*

(PR+) Inductive Codes

Besides the codes PR1-PR3, more inductive codes have emerged from the findings. These PR+ inductive codes are *Critical Mass, Funding*, *Liability*, and *Volatility of the Market*.

Critical Mass

The critical mass was observed to be a barrier for the MaaS provider and a success factor for building the platform. In building a MaaS platform, the critical mass describes the minimum number and overall coverage of MSPs that need to be on the platform to be economically viable, accepted and adopted by the users.

Without reaching the critical mass on the platform, the users would not use the platform because of alternative, more attractive options. The findings of this thesis emphasise the importance of achieving such a critical mass (I6, I7, I10, I14).

I6: "when you have the critical mass of mobility providers then others will definitely want to be part of it."

I7: "that brings us back to this critical mass. We have to quickly get other service providers involved so that this application is really noticed. In my opinion, it's still not big enough and I think we're lagging behind, so we're trying to get more service providers involved until we have a critical mass."

I10: "we did it back in 2018, and one of the learnings from that is we didn't have everything on offer […]. Some users didn't want to use it because the thing that they wanted wasn't within the offering."

I14: "the MaaS solution can only work […], if there are all providers, so we can't have only half of them. Because in that case, people would still think about having one integrated solution or more apps for their providers."

Funding

Another barrier for MaaS providers is funding. Funding is an essential factor in building a MaaS platform. Funding sources can originate from public funding, private investments, or, once established, revenue from the platform's operation. The findings reveal that time-limited funding is a significant barrier for MaaS providers. While funding helps for the initial phase, the project is observed to be at risk if the funding expires after a specific period, "we had applied for funding from the federal government […]. However, these are usually limited in time, with funding usually limited to one or two years" (I1). Reliance on such public funding can be risky; some get it, and others do not. For example, I10 reports that "we've been lucky to have the (name) funding, which came from the department for transport. But most of our funding is capital funding, so it's fine for upfront development costs" (I10).

Further, the challenge of different funding models is emphasised. These differ from the individual countries and are also strictly regulated (I2, I4):

I2: "but what was a bigger hurdle, or a bigger issue for us, was the financing of the project. (Case country) has a different financing model for each canton, and until now, innovation projects that are not necessarily related to the core business have not been financed by the public sector."

I4: "it is important to rethink the whole funding […]. Public funding is not enough to provide those services to everyone, so we need to find out the way how we can do more with less money […]. So if that city is providing some service that is already available in the markets. Then basically, the state aid rule says that you cannot provide public funding for such a service."

Most MaaS providers found the projects costly, and that public funding alone was insufficient (I4). For example, I7 stated, "these are all expensive services, and the understanding is often not there that of course, mobility costs money" (I7). Other evidence shows that it had become challenging to control the operating costs of such platforms (I10, I13, I15). In addition, labour costs can create challenges for funding (I15). These points underscore the growing importance of establishing a viable and sustainable funding model for the MaaS platform:

I10: "so there is a very low tolerance for operational costs, and the perspective now is that we should be breaking even on Mobility as a Service. There are a lot of requirements, and the cost is quite high in terms of OpEx (Operating Expense) product management."

I13: "a lot of them are struggling or at least having trouble finding enough capital for their operations."

I15: "our main challenge is we've run out of money […]. The cost of labour has gone up, and now we need to finish that project."

Liability

Liability for the MaaS provider can be experienced as a barrier as it determines who is responsible for any problems or legal issues associated with the provided mobility services. One question Kamargianni and Matyas (2017) ask is: Who will be responsible for failures or criminal activities? It is evident that addressing liability upfront is crucial to minimise risks and ensure a reliable, secure MaaS platform.

Findings reveal that liability has been a barrier in the context of fraud. One participant indicated that they experienced fraud and that it often involved complex cases in which it had to be clarified with the mobility service providers involved to decide who should bear what costs, “we had quite significant cases of fraud, which were often carried out via a mobility service provider […]. So, of course, you have to discuss the cases with the affiliated mobility service providers, what do we have to pay, how do we pursue it, do we block them and so on” (I2). Another participant indicated that they could not have offered their services without taking a specific business risk while setting up the platform, “we as company also took a certain risk, because we wanted to go out” (I3). Thus, the MaaS provider must accept liability, and potential fraud or other failures in the MaaS platform must have clear responsibilities; otherwise, the projects will likely fail (I5, I8):

I5: *“you’re responsible for your own replicating payment, and the car club operator is responsible for their own due diligence.”*

I8: *“so I’ve had or been in situations where we’re working on a city-based project and the city said, well, we’ll collect the money, but we’re not taking any responsibility for fraud. That will be the mobility providers. And the mobility providers said, if you collect the money, you need to do this for protection. That killed the project.”*

In particular, multi-modal liabilities are complex as multiple actors are involved, “so, what we struggle with now is that an operator can be liable for their part of the journey across the world […]. But we’re only responsible for our small part of the journey now. So multi-modal liabilities are where it gets exciting.” (I10). Here, service-level agreements can be complex and must ensure that the responsible party acts appropriately when problems arise, “service level support; how do we handle support from a customer? Does the transport operator have an interface for us to, for example, stop a rental or do some refunding if there’s a faulty vehicle?” (I13).

Volatility of the Market

The market's volatility can be experienced as a barrier when building a MaaS offering. In this context, market volatility refers to the unpredictability of market conditions and new actors emerging for building a MaaS platform. These uncertainties can make it challenging for a MaaS provider to offer constant services. Reported evidence shows that this barrier is experienced in practice. It is described that the uncertainty of whether MaaS providers, which are integrated today, will still be in the market tomorrow. MaaS providers report that participating service companies' ownership structures and business models change frequently, making it difficult for the provider if an integrated company becomes suddenly unavailable (I1). Another problem described is that because of this dynamic market, it can be challenging to keep the solution up to date (I2, I9). Finally, it could also lead to many MaaS solutions, resulting in a fragmented market, “so there’s a potential scenario where everyone has a MaaS solution, but not one is doing very well because there are too many MaaS solutions” (I10). Therefore, adopting a flexible and adaptable approach to tackle volatile conditions is essential. The following statements underline this:

I1: *(1) "three years ago, we had many more providers on the market, many of which have already disappeared or been bought, merged, and so on. This means that it is really an issue that when we make the effort to integrate someone, we also want to be sure that this provider will still be there the day after tomorrow."*

(2) "I do see the volatility as a major challenge, i.e. the fact that, how should we put it, the ownership structure likes to change, but so do the business models. And that is of course something that reduces the service on our app."

I2: *"first of all, the market is dynamic, so on the one hand players appear, but players also disappear again. In (our city) we had integrated them, but one month before the end they went bankrupt."*

I9: *"we always keep the offers up to date, because the market is very volatile and many offers enter the market, leave the market. There is volatility in the market, you can of course be unlucky, that there are providers who withdraw from the market, who have perhaps just integrated themselves with us."*

5.4 Selecting Key Patterns for Discussion

For selecting the key patterns to discuss further, the patterns with the highest value creation were selected. Value in this context means that the patterns provide new information to the body of knowledge or have managerial implications. Thus, patterns that just confirmed barriers from literature are presented in the following paragraphs and not discussed in the following chapter. Patterns that amend, contradict, reduce, or show mixed results were chosen for discussion.

The selection is visualised in Table 42, which refers to the findings of the cross-case analysis previous Section 5.3. This visualisation is helpful because it shows which key patterns were selected across the barriers for each theme. In addition, it allowed to pinpoint emerging key observations (*see* Table 41).

These key observations are then linked back in the following subsection to past research by discussing and underpinning the differences through empirical evidence (*see* Chapter 6). From each barrier theme, three observations were made with the following labels: Key Observation 1, Key Observation 2 and Key Observation 3.

Table 41. Emerging Key Observation Based on Patterns

Emerging Key Observations ("so what")	▪ Unique Platforms Hinder Standardisation and Interoperability ▪ The Need to Modernise Traditional Actors Is Causing High Integration Efforts ▪ Reliance on DSPs Poses Architectural Challenges to Maas Providers	▪ Need to Foster User Acceptance Through Triggering Behavioural Change ▪ Need to Build Trust Through Collaboration and Championing MaaS ▪ Need to Build Up Technical In-House IT Skills	▪ Inconsistent Regulation and Legal Requirements Pose Challenges ▪ Reaching Critical Mass is Challenging Because of Limited Funding ▪ High Volatility and Multi-Modal Liabilities Pose Challenges for Regulation

Table 42. Overview of Barrier Themes with their Key Patterns and Links to Past Research

Technology and Data Patterns (*see* Section 5.3.1)	**Social and Cultural Patterns** (*see* Section 5.3.2)	**Policy and Regulation Patterns** (*see* Section 5.3.3)
	Barriers and their Key Patterns with Past Research	
Data Security and Privacy (TD1): ➢ Amending Cottrill (2020): Before the implementation, extensive workshops were held between all the parties to ensure all necessary precautions. ➢ Amending Huang (2022): Data privacy strategies were based on the need-to-know principle. **Lack of Openness of Data, Standardisation, Data Silos, and Interoperability (TD2):** ➢ Amending Servou et al. (2023): Unique and custom platforms are causing high integration efforts. ➢ Amending Ghazy et al. (2021): Continuous interface changes are tedious and require multiple adaptions. ➢ Mixed Pattern for Kamargianni and Goulding (2018): Participants question country-wide policies but are part of initiatives. ➢ Amending Karlsson et al. (2017): Providers are starting to develop harmonised APIs.	**Acceptance of Users, Travel Behaviour, and Lack of User Trust (SC1):** ➢ Amending Alonso-González et al. (2017): Discovery of critical mass. MaaS becomes successful when reaching the critical mass. ➢ Amending Polydoropoulou, Pagoni, Tsirimpa, et al. (2020): It is not just the persona; it is the lifestyle of everyone around that person. ➢ Amending Valkovic et al. (2021): Findings confirm reputation and branding to be critical. Offering the platform under an established brand increases acceptance. ➢ Contradicting Kandanaarachchi et al. (2022): While a trust and collaboration framework is important, an official stamp, “Certified MaaS Provider”, through a certification process would help more. **Competition, Losing Monopoly Postion, Control and Influence (SC2)** ➢ Amending Karlsson et al. (2017): Evidence shows that competition remains a major obstacle in the transportation sector. ➢ Amending Alyavina et al. (2022): Companies are afraid of cannibalising their own app and must balance between new customers and the risk of competition. ➢ Amending Arias-Molinares and García-Palomares (2020): Initiatives like committees or boards are observed to ensure fairness.	**Demand Estimation, Creation of Business Models, Tailoring of Services (PR1):** ➢ Only Conformative Patterns. **Legal Issues, Bureaucracy, and Institutional Barriers (PR2):** ➢ Amending Kamargianni and Matyas (2017): MaaS providers are bound by municipal and international laws. ➢ Amending Smith and Hensher (2020): The automotive industry lobby is strong, and politicians think in political cycles. ➢ Amending Kivimaa and Rogge (2022): Short-term experimentation with pilots helps politicians to understand and buy into it.

Modernisation of ICT Infrastructure, Internet Coverage, Real-Time Information Available (TD3): ➢ Mixed Pattern for Smith and Hensher (2020): Progress is observed; still, traditional companies lack technical readiness and, thus, real-time data. ➢ Contradicting Ghazy et al. (2021): Significant modernisation of backends is required to build such a layer. ➢ Amending Hasselwander and Bigotte (2022): Especially supporting technologies and their deep integration pose challenges. **Unclear or No Platform Architectures Existing (TD4):** ➢ Amending Reyes García et al. (2020): Participants report that they struggle with defining a consistent user experience and platform. ➢ Mixed Pattern for Zhou et al. (2023) Enterprise architecture would help, but it is not their bread and butter to architect such platforms for the participants. ➢ Amending Yano et al. (2022): Infrastructure is still hosted on-premises, and there is little experience with cloud platforms.	**Difficulties for Users Related to Technologies (SC3):** ➢ Amending Alonso-González et al. (2017): MaaS providers try to simplify the accessibility to their services and conduct awareness-raising campaigns. **Missing Collaboration (SC4):** ➢ Amending Karlsson et al. (2020): Participants report that a culture of no collaboration is caused by missing know-how on developing MaaS solutions. ➢ Contradicting Arias-Molinares and García-Palomares (2020): While opposing objectives might be one reason, it is reported that talking to some involved parties is politically sensitive. **Missing Leadership and Vision (SC5):** ➢ Contradicting Guyader et al. (2021): A lack of general leadership involvement is observed. In addition, taking the lead can be dangerous. ➢ Amending Valkovic et al. (2021): Participants are missing guidance on what their role is. **Skills and Knowledge Gaps (SC6):** ➢ Amending Crozet and Coldefy (2021): Participants report that know-how and resources are missing to develop technical MaaS solutions. ➢ Amending Kayikci and Kabadurmus (2022): Recruitment processes are not tailored to these skills; public companies are confronted with new competencies that may not have previously needed. ➢ Amending Smith and Hensher (2020): The lack of senior leadership skills requires the public MaaS provider to rely on third parties and consultancies.	**Poor Governance Frameworks, Policy, and Regulation Challenges (PR3):** ➢ Mixed Pattern for Karlsson et al. (2017): Insufficient frameworks and different regulatory regimes were causing barriers to develop MaaS. The problem lies in formulating those frameworks. ➢ Mixed Pattern for Tabascio and Brail (2022): Cities have little regulative power for MaaS. Inconsistent regulations across Europe make it difficult to formulate policies. ➢ Amending Arias-Molinares and García-Palomares (2020): Participants report that too much regulation leads to unattractive MaaS, while too little towards high market volatility.

In Table 42 only amending, contradicting and mixed patterns were chosen for further discussion in the next chapter. The rationale behind not selecting confirmative patterns is described in the following paragraphs.

5.4.1 Rationale for Choosing Key Technology and Data Patterns

Looking at the confirmative technology and data patterns, mainly data security and privacy patterns were excluded from the discussion. This was done because the findings confirmed that the study's participants face this barrier, but little amended characteristics from the literature. For example, Smith and Hensher (2020) emphasised that the need to resolve security and privacy issues was just confirmed by the findings, "we have also set very strong rules here and said that certain data protection rules simply have to be followed" (I1). Also, Cottrill (2020) recognised the importance of addressing data privacy issues early, which was supported by the data that "there were whole workshops between the parties before we even started and it was clear there that it has to be taken into account“ (I2). Further, it was confirmed that early implementation of GDPR helped overcome barriers (Polydoropoulou, Pagoni, & Tsirimpa, 2020). Thus, it became clear that data privacy and security were just initial barriers the participants overcame by implementing data privacy strategies on a need-to-know principle (Huang, 2022). Other patterns excluded were confirming technical challenges mentioned in the academic literature. For example, the pattern of Kamargianni and Goulding (2018) was confirmed by expressing the need to have more physical and technical infrastructure, "we need the physical infrastructure to support, for example, cycling and e-scooters" (I4). Smith and Hensher (2020) design of platform architectures was confirmed, "one challenge has been how you architect your technology" (I8).

Further, it became clear to the participants that many edge cases exist and that standardisation and data openness is crucial, confirming the findings of Gace and Babic (2020).

5.4.2 Rationale for Choosing Key Social and Cultural Patterns

Investigating the social and cultural patterns contributes to a better understanding of the barriers the MaaS provider faces. The following patterns only confirmed the literature and were not selected for further discussion. Looking at the adoption of MaaS solutions, Toyama (2022) highlighted the importance of the price value in MaaS offerings. This was confirmed by participants of this study, who reported that price value was a significant factor for them, “users were not ready for that model yet, and it came across as quite expensive" (I10). This suggests that potential users are considering the cost benefits of MaaS before deciding to adopt it, highlighting the importance of competitive pricing strategies in the MaaS market. Another pattern introduced is the one by Arias-Molinares and García-Palomares (2020), indicating that users struggle to navigate all the information and technology associated with MaaS. Again, the results confirmed that a technical understanding is a challenge, “you know, it’s not a big sell in terms of what the idea of it is on the concept. But with a lot of the people internally, they’ve never heard of MaaS” (I18). This emphasises the need for user-friendly interfaces to ensure the successful adoption of MaaS but does not need further discussion. In two studies, Smith et al. (2022) and Smith et al. (2019) highlighted the need for long-term analyses of MaaS adoption and the importance of inter-organisational collaboration in the MaaS innovation process. The participants of this study confirmed both aspects, indicating the need for long-term research efforts and adopting collaborative strategies. The next chapter will discuss these strategies with the patterns SC4 listed in Table 42.

Other patterns included the establishment of MaaS champions that emerged in the work of Mulley and Nelson (2020), Smith and Hensher (2020) and Kandanaarachchi et al. (2022). This study confirmed their findings, indicating that the presence of MaaS champions was critical to success, "we don't really have someone championing or expanding shared mobility" (I15). As a result, advocates play a significant role in establishing a MaaS platform. In this context, Meurs et al. (2020) discussed the formation of MaaS alliances. The findings confirmed this formation process, indicating the importance of strategic partnerships in the MaaS business ecosystem. In particular, the concept of a MaaS champion and leadership will be discussed with the amending patterns in SC5.

In conclusion, the patterns of social and cultural aspects highlighted the diversity of MaaS, confirming price value, user-friendly technology, long-term analysis, inter-organisational collaboration, MaaS champions and strategic alliances as important factors. These factors are discussed with the observations of Table 42 in the next chapter.

5.4.3 Rationale for Choosing Key Policy and Regulation Patterns

Various policy and regulation patterns have been confirmed by this research, which contributes to understanding the barriers of MaaS providers in this theme. The following patterns were confirmed but not chosen for further discussion.

In their study, Mulley and Nelson (2020) pointed out that the business model discussion is still in its early stages and that educational elements must be included in the business plan. MaaS providers confirmed this and reported that they struggle to establish a business plan, “the business models have been proven not to work at the city level” (I8).

Besides this pattern, Arias-Molinares and García-Palomares (2020) suggested that MaaS should be tailored to B2B business models. This study confirmed that MaaS was reportedly subsidised, indicating that a sustainable business model needs to include B2B components. Concerning business models Turoń (2022) discussed the readiness of business models using a business model CANVAS. Using such modelling techniques was confirmed by the participants and thus underlines the importance of using frameworks to develop and refine business models. These business model patterns were not discussed further, as the maturity of those business models is still in the early stages, and the findings confirmed this. Furthermore. Murati (2020) highlighted the lack of a harmonised legal framework for MaaS. The participants confirmed that “the digital legal framework is not clear in our country” (I12). This was further reinforced by Pagoni et al. (2022), suggesting that EU legal and regulatory frameworks need to be revisited. This was confirmed by the participants, who expressed uncertainty about which EU legal frameworks apply to MaaS. The patterns in this area (PR2) will be discussed in the next chapter. Next to these legal patterns, regulatory patterns were confirmed. Mulley and Nelson (2020) iterated on the importance of fairness and level playing fields in the MaaS sector. Participants confirmed this, indicating that the “aspect of fair sharing and sharing the money between operators becomes challenging” (I16). Mainly the factor competition will be discussed under SC2 in the next chapter. In addition, Haavisto and Mladenović (2020) argued that regulation should not be the starting point for cooperation. This was confirmed by the participants, who reported that mutual benefit rather than regulatory requirements drive cooperation. Specifically, Jittrapirom et al. (2020) emphasised developing successful criteria for cooperation. Participants confirmed this, indicating that success criteria are essential for practical cooperation.

5.5 Conclusion on Case Study Findings and Patterns

The previous sections presented the empirical results of the case studies. These results were based on the within-case results.

Section 5.1 analysed the cross-cases and showed how different MaaS providers have been building up their business ecosystems.

Then, Section 5.3 analysed in-depth the cross-case findings of this thesis. For this, it was demonstrated and evaluated how the participants of this study problematise, interest, enrol and mobilise their MaaS business ecosystem. As a result of this activity, it was confirmed that participants share the same conceptual understanding (mobilisation), while approaches (interessement), onboarding (enrolment) and activities to evolve the network (mobilisation) differed. After that, the deductive barriers of the literature were evaluated and inductively amended with findings from this study. The barrier theme Technology and Data (TD1-TD4) was amended with the following codes: *Accuracy of Data, the Flexibility of Existing Commercial Solutions, Integration Efforts* and *Manual Processes Not Digitised.* The Social and Cultural (SC1-SC6) theme was amended with these codes: *Inclusion Agenda, Multiple Existing Apps,* and *Prioritisation.* Finally, Policy and Regulation (PR1-PR3) was amended with the following codes: *Critical Mass, Funding, Liability,* and *Volatility of the Market.*

Finally, Section 5.4 selected the key patterns forming the basis for the discussion and outlined the contributions in the following chapter. Here, patterns providing the highest value were chosen, and observations were visualised in Table 42. Lastly, the rationale for choosing the key patterns was outlined for each barrier theme.

6 Discussion of Results

This chapter discusses the findings of the previous chapter. It draws out how the findings link to past research and how they have generated significant new insights into understanding and overcoming the barriers for MaaS providers. For this discussion, the previous chapter's evaluation scheme helped prepare the data for discussion. This chapter outlines the contributions following the scheme of Presthus and Munkvold (2016) and is structured into five sections. Sections 6.1 to 6.4 consider empirically what the findings have shown about barriers to MaaS providers. These sections discuss the thought-provoking patterns found in each barrier theme. In the next step, success factors are synthesised, which describe strategies to overcome those barriers (*see* Section 6.5). Finally, Section 6.6 concludes the observations and patterns about the actor network conceptualisation of MaaS business ecosystems. Here, a novel CABS framework is presented. Closely linked to the discussion, Appendix J outlines prospects which detail future avenues for MaaS.

6.1 Introduction

Previous research by Christiaanse (2019) recognised that for MaaS services, three thematic areas are relevant: technical, economic, and sociological. Besides that, other studies have identified that uncovering barriers would facilitate and govern the development of MaaS (Kamargianni & Matyas, 2017; Wong et al., 2020). This study took a different approach by identifying three main thematic areas where barriers occur in the MaaS business ecosystem: technology and data, social and cultural and policy and regulation (*see* Table 41).

Therefore, the initial classification of Christiaanse (2019) was extended and put into another context with barriers. The following sections discuss the patterns that emerged within these three themes.

6.2 Discussing the Technology and Data Patterns

For the theme Technology and Data, four key barriers TD1-TD4 with their key patterns have been identified (*see* Table 42). They all deal with technical or data-driven problems the MaaS provider is facing.

Emerging Observations Derived from Technology and Data Barrier Patterns

Gace and Babic (2020) realised that technology and data barriers can only be explored after MaaS platforms are widely deployed in practice. This study researched and interviewed the biggest MaaS platforms in Europe, and the following paragraphs introduce three observations that emerged: *Unique Platforms Hinder Standardisation and Interoperability*, *The Need to Modernise Traditional Actors is Causing High Integration Efforts*, and *Reliance on DSPs Poses Architectural Challenges to Maas Providers*. First, new aspects of the patterns are discussed, and then inductive codes are included in the discussion.

6.2.1 Unique Platforms Hinder Standardisation and Interoperability

The first observation is that unique platforms hinder standardisation and interoperability. To come to this observation, the patterns of Servou et al. (2023), Karlsson et al. (2017) and Ghazy et al. (2021) are discussed, and the inductive code of *Manual Processes Not Digitised* is added to that discussion. All these three patterns have emerged from barrier TD2: *Lack of Openness of Data, Standardisation, Data Silos, and Interoperability*. The patterns not only confirmed this barrier but amended the findings.

For example, Servou et al. (2023) outlined that the data sets' heterogeneity causes data standardisation and scalability issues. The findings showed that data heterogeneity caused issues, and the participant's unique implementations hindered standardisation development. The data underlines this: "every single integration will be different, and you must work with them a lot" (I11). Not only are the implementations different, but also it is observable that integration efforts with each new provider are increasing and becoming complex. Reasons for that have been explained by the participants of this study stating, that “every provider has a unique system” (I14) and an “own way of working” (I12). This shows that overarching standards are needed, as Karlsson et al. (2017) outlined.

However, the findings showed that progress had been made, as providers are starting to develop harmonised APIs “we’ve got them harmonised by using the same supplier’s technology with an API available” (I15). Further, the inductive code of manual processes not digitised contributes to this discussion, especially around smart ticketing, "there were no digital tickets till 2019" (I11). This finding explains why the MaaS providers struggle to establish overarching standards and amends the findings of Ghazy et al. (2021), stating that missing metadata produces data silos, “every change, the interface also changes, of course, and that makes it quite tedious.” (I1). As a result, overcoming this observation will become even more critical when the ecosystem continues to expand.

6.2.2 The Need to Modernise Traditional Actors is Causing High Integration Efforts

The second observation that emerged is that the need to modernise traditional actors is causing high integration efforts for MaaS providers. This observation was made by interpreting the patterns of Smith and Hensher (2020), Ghazy et al. (2021), Kamargianni and Goulding (2018), Hasselwander and Bigotte (2022) and the inductive codes *Accuracy of Data* and *Integration Efforts*. These patterns mainly emerged from barrier theme TD3: *Modernisation of ICT Infrastructure, Internet Coverage, and Real-Time Information Available*.

Kamargianni and Goulding (2018) indicated that functioning ICT infrastructure is a preliminary for MaaS. While ICT infrastructure and having real-time data available play an essential role for all participants, a mixed picture of readiness was observed, “it is a very mixed picture in terms of the readiness of operators from a behavioural, a business and a technical readiness to integrate into MaaS” (I18). Especially the readiness of ICT infrastructure and the technical readiness of the providers differ in the cities. Thus, for some participants, this is considered a significant barrier, while for others, it is not posing a significant barrier.

One aspect inductively amended to this barrier has been the *Accuracy of Data*. The MaaS providers have no real-time data available but need it, “we needed real-time data from usage. I can't do a minutes package if I don't have the real-time data (I2)”. Smith and Hensher (2020) emphasise that real-time information is necessary for the success of MaaS projects, and progress has been made in this regard.

However, a mixed pattern was observed in the field. While overall progress is observable, traditional enterprises often lack the technical readiness to provide real-time data, which hinders the effective implementation of MaaS.

Reasons for that were identified by Hasselwander and Bigotte (2022), who emphasise on the essential role of ICT tools and technologies in MaaS. This study complemented that by identifying that especially supporting technologies and their deep integration are particularly challenging, “the first thing you do is open the lock with Bluetooth. (MaaS provider) did not actually want to support this technology” (I2).

In addition, this study inductively found that integration efforts were a significant barrier to enabling the MaaS concept. Concretely, these efforts span from technical and legal to time investments of the different actors. One participant stated that “they see that integration is hard. It will cost a lot of money and time” (I14). This finding suggests that supporting technologies are available, but their effective integration into the MaaS ecosystem remains the major barrier.

In addition, Ghazy et al. (2021) suggested that a data layer on top of the infrastructure could facilitate the efficient functioning of MaaS. However, this suggestion contradicts the current state of the MaaS providers. Creating such a layer would require significant modernisation of backends. The findings thus indicated a gap between the ideal state and the reality.

In conclusion, while the importance of having real-time data and ICT technology is recognised, the practical challenges of technical readiness, backend modernisation and integration efforts are causing significant barriers to establish MaaS platforms. These challenges must be addressed to ensure the successful adoption and growth of MaaS platforms.

6.2.3 Reliance on DSPs Poses Architectural Challenges to MaaS Providers

The third observation which emerged showed that the MaaS provider's reliance on DSPs poses significant architectural challenges. This observation was reached by interpreting the patterns of Reyes García et al. (2020), Zhou et al. (2023), Yano et al. (2022) and the inductive code of *Missing Flexibility of Existing Commercial Solutions*. These patterns emerged from the thematic barrier TD4: *Unclear or No Platform Architectures Existing*.

The inductive pattern revealed little or no flexibility in existing commercial MaaS solutions. Especially it was pointed out that the participating MaaS providers "were unable to offer individual components" (I1) and that MaaS providers wanted to keep ownership of the platforms "so we can handle it, we can change it; we can update it" (I14). Similarly, the findings indicated that the complexity of MaaS platforms requires adaptable and modular platform architectures. However, this barrier is perceived differently by the participants of this study. Through analysing the data, it was found that MaaS platform providers who rely on digital service providers indicated that the flexibility of the existing commercial solution is experienced as their primary barrier.

In contrast, the MaaS providers who do not rely on digital service providers indicated that IT and architectural challenges have been the main barriers to them. The patterns support this observation. Here, Reyes García et al. (2020) pointed out that the lack of a standard architecture is causing complex integration issues. As stated, the participants building their solutions expressed their struggle with defining a consistent user experience and platform due to a lack of common architecture, "we have an app, but it is not up to the standard of where we want it to be" (I10).

This finding suggests that the absence of a unified architectural framework constrains flexible and modular MaaS platforms. In that context, Zhou et al. (2023) proposed that enterprise architecture modelling could help to overcome this barrier. The findings indicated that enterprise architecture modelling would indeed be beneficial. However, this was not applied because participants lacked the expertise to architect such platforms. This finding indicates a gap between the potential of the MaaS solution and the practical capabilities of MaaS providers.

Additionally, Yano et al. (2022) noted an increasing shift towards cloud solutions. However, the findings showed that the MaaS providers have requirements to deploy MaaS services on infrastructure hosted on-premises. Again, little experience with cloud platforms among the participants was reported. As a result, the transition from hosting services on-premises towards hosting cloud platforms poses a significant challenge.

Here, the flexibility of commercial solutions is recognised as crucial for the success of MaaS. Namely, the lack of a standard architecture, the gap between potential solutions and practical capabilities, and the slow transition to cloud solutions explain the challenges of the MaaS providers for this issue. These barriers must be addressed to enhance the flexibility and effectiveness of commercial solutions in the MaaS sector. One strategy could be to work out a *clear solution strategy* that includes aspects of enterprise architecture modelling, as Zhou et al. (2023) pointed out. In future, especially, the modularity and inclusion of other aspects will become necessary.

Table 43 concludes the discussion around technology and data barriers and depicts data excerpts supporting the discussion of the observations.

Table 43. Thematic Data Excerpts Supporting the Observations Discussion of Technology and Data Barrier Patterns

Data Excerpts	**Emerging Observations from the Patterns**
1) "I cannot do one type of integration, and then all the others can join easily. ***Every single integration will be different****, and you must work with them a lot." (I11)*	**Unique Platforms Hinder Standardisation and Interoperability** **Supporting Patterns**: 1) Servou et al. (2023) 2) Karlsson et al. (2017) 3) Ghazy et al. (2021)
2) "Integrating all public providers is tough. Every provider has ***a unique system****; they have their own requirements and so on." (I14)*	
3) "But when we go to the platform, each one of the partners of the platform has their API, ***their own way of working****." (I12)*	
1) "Some of our more ***traditional operators*** *don't have potentially open APIs ready to be consumed externally." (I10)*	**Need to Modernise Traditional Actors is Causing High Integration Efforts** **Supporting Patterns**: 1) Kamargianni and Goulding (2018) 2) Smith and Hensher (2020), Ghazy et al. (2021) 3) Hasselwander and Bigotte (2022)
2) "The small companies ***don't have the infrastructure****. In [city], there will be more companies that don't have the infrastructure to join the project." (I12)*	
3) "They see that ***integration is hard****. It will* ***cost a lot of money and time****, and they don't see the profits, but we see the profits." (I14)*	
1) "We have an app, but it is ***not up to the standard*** *of where we want it to be." (I10)*	**Reliance on Digital Service Providers Poses Architectural Challenges to MaaS Providers** **Supporting Patterns**: 1) Reyes García et al. (2020) 2) Zhou et al. (2023) 3) Yano et al. (2022)
2) "We found that most of the providers in the market, if not all of them, couldn't ***deliver everything we wanted.****" (I18)*	
3) "Traditionally, you know you would have an IT team that will look after these systems as a whole, but ***increasingly*** *these are* ***cloud-based services."*** *(I16)*	

6.3 Discussing the Social and Cultural Patterns

For the theme Social and Culture, six key barriers SC1-SC6 with their key patterns have been identified (*see* Table 42). They all deal with social or cultural challenges the MaaS provider faces.

Emerging Observations Derived from Social and Cultural Barrier Patterns

A significant gap identified by Sochor et al. (2018) is that empirical evidence lacks which factors influence the development of MaaS, especially in the social and cultural areas. This study researched and interviewed the biggest MaaS platforms in Europe to find out which social or cultural barriers influence the development of MaaS. Based on the findings, three key observations emerged from analysing the patterns: The *Need to Foster User Acceptance Through Triggering Behavioural Change,* the *Need to Build Trust Through Collaboration and Championing MaaS, and* the *Need to Build Up Technical In-House IT Skills*. In the following, the patterns of these observations are discussed together with the inductive codes.

6.3.1 Need to Foster User Acceptance Through Triggering Behavioural Change

The first observation is the need to foster user acceptance by triggering behavioural change. This observation emerged from analysing the patterns of Alonso-González et al. (2017), Kandanaarachchi et al. (2022), Valkovic et al. (2021), Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) and the inductive patterns of having an *Inclusion Agenda, Volatility of the Market* and *Critical Mass*. The patterns originate from the barrier themes SC1: *Acceptance of Users, Travel Behaviour*, and *Lack of User Trust* and SC3: *Difficulties for Users Related to Technologies.*

Concerning user acceptance Alonso-González et al. (2017) suggested that MaaS users are not ready yet. The participants shared this view: “demand for subscription-based services was far below expectations and disappointing" (I2). Indeed, the MaaS providers tried to simplify the accessibility to their services and raise awareness through campaigns. With these actions, the MaaS providers were able to enhance user acceptance.

Still, behavioural change is also required in the aspect of collaboration. In this context, a trust and collaboration framework to foster user acceptance was proposed by Kandanaarachchi et al. (2022). However, applying such a framework contradicted the findings of this study as it would be too complex to follow. Instead, the participants indicated that an official certification process, such as a “Certified MaaS Provider” stamp, would be more effective than a trust and collaboration framework, “If there's a (brand) stamp on it, it can help users to trust better these companies" (I11). Thus, it becomes evident that the cities' formal recognition and certification process can play a significant role in fostering user trust and acceptance.

Such an official stamp will also help better control the market's volatility. Especially the volatility of the market was inductively found to be a key barrier for the MaaS providers to overcome, as stated by one participant: “I do see the volatility as a major challenge, for example the fact that, how should we put it, the ownership structure likes to change, but so do the business models. And that is of course something that reduces the service on our app” (I1). Moreover, an official stamp improves the branding. Valkovic et al. (2021) emphasised the importance of solid reputation and branding to increase user acceptance. The findings of this study revealed that reputation and branding are indeed critical:

“It was also difficult to win customers for this platform, for this solution, if you can't advertise it in a big way, with the names of the municipal transport companies” (I3). This finding emphasises the importance of solid branding and reputation management to foster user acceptance.

Another critical aspect which had been amended was the one of Alonso-González et al. (2017). They suggested that the more services offered, the better the user acceptance. This study confirmed this finding and amended it with the inductive code of having a critical mass, “that brings us back to this critical mass. We have to quickly get other service providers involved so that this application is really noticed” (I7). A critical mass indicates that MaaS becomes successful, and users start to adopt the platform when reaching a certain threshold of services in a specific region of interest.

Next to offering all possible mobility services in the platform, more customer research is needed to understand the users and their difficulties better. Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) emphasised the need for a deeper understanding of the key actors' motives. This study offered a better understanding of those motives. For example, evidence revealed the insight that it is not just the persona but the lifestyle of everyone around that person that matters “it's not necessarily a person's lifestyle or that particular persona, but it's actually the lifestyle of everyone around that immediate person" (I16). Thus, MaaS providers need to understand the users' social contexts and lifestyles to enhance the user acceptance of their platforms. Especially, awareness-raising campaigns and having an inclusion agenda will become essential for MaaS providers to advertise their platforms.

Notably, the findings revealed that the inclusion agenda need to be tackled in "regional transport partnerships have a policy objective to be able to increase inclusion" (I15).

Here, it needs to be ensured that mobility criteria are met, and that the platform is accessible to all age groups. That means the platform is easy to use and has moderate pricing. If done right, having an inclusion agenda lowers the barriers to using MaaS platforms and thus increases usage.

To conclude, the discussion of the patterns clearly showed the need to foster user acceptance by triggering behavioural change. Fostering user acceptance from the view of the MaaS platform providers requires a multifaceted approach. This approach needs to simplify the access to the services with an inclusion agenda, raising awareness through campaigns, and obtaining certification from a central party to achieve a critical mass and strong branding of the MaaS platform.

6.3.2 Need to Build Trust Through Collaboration and Championing MaaS

The second observation outlines the need to build trust through collaboration and championing MaaS. This observation emerged from analysing the patterns of Guyader et al. (2021), Valkovic et al. (2021), Arias-Molinares and García-Palomares (2020), Karlsson et al. (2020), Alyavina et al. (2022), Karlsson et al. (2017) and the inductive pattern of *Multiple Existing Apps*. The patterns originate from the barrier themes SC2, which addresses competition; SC4, which addresses collaboration; and SC5, which addresses leadership.

Trust within the MaaS ecosystem was found to be central to championing MaaS. Karlsson et al. (2020) recognised that failing to collaborate across the ecosystem is caused by unclear roles and responsibilities.

It became evident that missing collaboration is mainly triggered by missing know-how on developing MaaS solutions “there is no culture of working together or cooperation or developing services together […]. There is no know-how on how to create these solutions together” (I4).

Here, as identified by Karlsson et al. (2017), cooperation between regional and local actors is vital. However, this study indicated that competition remains a significant obstacle in the transportation sector “a lot of transport operators are, of course, afraid we are competing with the same customer” (I13). This finding reiterates the importance of fostering cooperation in a competitive environment.

Valkovic et al. (2021) noted a mismatch between mode share targets and investments. The results explain that, as participants report missing guidance on their role, indicating a more precise direction and alignment between targets and investments, “the operators need more help. At least guidance on what they need to do, what their role is” (I4). This finding indicates that better knowledge sharing is required, and new capacities must be built.

In this context, Arias-Molinares and García-Palomares (2020) identified that opposing objectives in private and public organisations might trigger such collaboration barriers. However, this study contradicted this, identifying that political sensitivity when dealing with certain parties has been a major barrier to collaboration for the MaaS providers, “operators are a very sensitive, politically sensitive space, so I do not speak to them directly unless one speaks to me” (I15).

Another factor amended by this study has been the fear of losing power positions, as highlighted by Alyavina et al. (2022). The findings revealed that building trust has been vital, as companies are afraid of cannibalising their own app and must balance between attracting new customers and the risk of competition:

"until this idea has manifested itself, I'm not cannibalising my own offering here" (I7). This finding indicates that complex strategic considerations are involved in championing MaaS. One inductive pattern recognised here was the existence of multiple apps, which has been the main reason for the competition observed.

It was found that a clear and attractive value proposition and a clear strategy are required for the MaaS provider to position the MaaS platform in the market.

One consideration is fairness, as initially emphasised by Arias-Molinares and García-Palomares (2020). Empiric data amended this factor, showing that initiatives like committees or boards can ensure fairness, "(we) set up some kind of committee or board with MSPs to discuss different ideas" (I6). That suggests that structured approaches can help to promote fairness in the MaaS ecosystem. Here, structured approaches are co-creation to develop the MaaS platform and regular exchange bodies between all actors.

Still, championing MaaS requires leadership and vision. This finding has been highlighted by Guyader et al. (2021), stating that leadership involvement is critical in managing and resolving tensions in the ecosystem. The participants emphasised the importance of leadership, but at the same time stated, "we don't really have someone championing or expanding shared mobility" (I15). The reasons for that are diverse. One reason explaining the general lack of leadership involvement was the perception that taking the lead can be risky, "taking the lead can be very dangerous" (I12).

Nevertheless, it is evident that the participant cases with MaaS champions have been more successful than the others. This suggests that leadership is crucial, but its potential risks can deter active involvement.

The slow decision-making in public sector organisations and traditional mindsets among essential decision-makers amplify that. One way to battle against those traditional mindsets is to show the potential of MaaS. Evidence showed that through the MaaS platforms, faster decisions could be achieved, and key stakeholders could be persuaded, “we got them, or forced them, to think about a mobility strategy for the city” (I2).

In conclusion, building trust in MaaS ecosystems requires strong leadership in managing strategic considerations. This is driven by a culture of cooperation, which is enabled through fairness in a competitive environment. Here, MaaS champions can help to overcome political sensitivities. All these findings help foster a culture of collaboration and will help champion MaaS.

6.3.3 Need to Build Up Technical In-House IT Skills

The third observation is the need to build up technical in-house IT skills. This observation emerged from the patterns of Smith and Hensher (2020), Kayikci and Kabadurmus (2022), Crozet and Coldefy (2021) and the inductive code of *Prioritisation*. The patterns originate from the barrier theme SC6: *Skills and Knowledge Gaps*.

This study revealed that skills and knowledge gaps are major barriers for the MaaS provider. Discussing this, Crozet and Coldefy (2021) emphasised the importance of new skills that the MaaS provider can use to position itself as a trusted party. The evidence gathered suggests that MaaS providers lack the resources and expertise to build MaaS platforms effectively: “providers like us who actually have a classic brick and mortar business or a strong infrastructure business, are simply confronted with competencies that they may not have needed in the past” (I9).

To overcome this, the participants relied on external consultants and other third parties to advise them on building their MaaS platform. However, this results in a dependency on external resources and the participants started to realise that they need to build up their in-house IT capabilities: “I don’t think that’s the right approach in the long term because if they want to deliver this, they should do it in-house, retain the expertise in-house, and develop the relationships internally rather than paying consultants to do it for them” (I18).

To be able to do that, public companies who want to develop and operate MaaS platforms need to hire skilled people. However, as Kayikci and Kabadurmus (2022) reported, a labour shortage of skilled people exists in the field. This finding was confirmed by this study and amended by the insight that recruitment processes are not tailored to hire people with these skill sets: “we would like certain recruitment processes […], to be more tailored to us” (I9). In addition, the evidence showed that the limited funding of those projects resulted in challenges to create the necessary job positions: “it is just about money. Do they have enough funding or income to spend on attracting new development and developers?” (I13).

These findings indicate that existing recruitment strategies must be adopted to develop the necessary resources and know-how to attract and retain the necessary talent. According to Smith and Hensher (2020), these skill gaps include senior leadership, often lacking digitalisation skills. This study confirmed that and suggested that improving these skills could reduce reliance on third parties and consultants. In addition, this increases awareness by anchoring the platform firmly to the city's goals.

However, this takes time, and an inductive prioritisation strategy is needed. Here, the participants reported that adopting a prioritisation strategy was essential to develop MaaS and streamlining their project tasks: “lots of projects are going on, and so sometimes we see conflicts. What is the priority?” (I10). This finding suggests that developing a prioritisation strategy which aligns between the different actors is essential. Building up technical in-house IT skills requires many aspects to be taken care of - digitalisation skills among senior leadership, revising recruitment strategies to attract skilled talent and developing the necessary departments and know-how internally. Table 44 concludes the discussion around social and cultural barriers and depicts data excerpts supporting the discussion of the observations.

Table 44. Thematic Data Excerpts Supporting the Observations Discussion of Social and Cultural Barrier Patterns

Data Excerpts	**Emerging Observations from the Patterns**
1) "**MaaS** alone and technology alone **in isolation will not create behavioural change**. And it is very important to be able to teach people, educate people, sensitise people." (I17) 2) *"There are people behind the users […], we need to **change the habits**, and **it won't be a quick change**." (I4)* 3) *"**People** in the region **were not ready** for that model yet, and it came across as quite expensive." (I10)*	**Need to Foster User Acceptance Through Triggering Behavioural Change** **Supporting Patterns**: 1) Valkovic et al. (2021), Kandanaarachchi et al. (2022) 2) Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) 3) Alonso-González et al. (2017)
1) *"There already is commercial competition between market parties […]. A lot of transport operators are, of course, **afraid** we are **competing with the same customer.**" (I13)* 2) *"There is still **nervousness about how it will impact patronage** on my mode […] and a bit of I want to keep control of myself, of my piece […]. We are going to push all things equally." (I10)* 3) *"We don't really have **someone championing or expanding** shared mobility." (I15)*	**Need to Build Trust Through Collaboration and Championing MaaS** **Supporting Patterns**: 1) Karlsson et al. (2017), Arias-Molinares and García-Palomares (2020) 2) Alyavina et al. (2022), Valkovic et al. (2021) 3) Guyader et al. (2021), Karlsson et al. (2020)
1) *"Classic providers, providers like us who actually have a classic brick and mortar business or a strong infrastructure business, are simply **confronted with competencies that they may not have** needed in the past." (I9)* 2) *"There is a question of skills. There is a fundamental question of **skills and organisation.**" (I12)* 3) *"**We're not used to having digital products** that are trying to compete with some huge players. So, we must learn quickly in that area and leverage the technology providers." (I10)*	**Need to Build Up Technical In-House IT Skills** **Supporting Patterns:** 1) Kayikci and Kabadurmus (2022) 2) Smith and Hensher (2020) 3) Crozet and Coldefy (2021)

6.4 Discussing the Policy and Regulation Patterns

For the theme Policy and Regulation, three key barriers PR1-PR3 with their key patterns have been identified (*see* Table 42). They all deal with policy or regulatory challenges the MaaS provider faces.

Emerging Observations Derived from Policy and Regulation Barrier Patterns

A significant gap identified in the policy and regulation space was identified by Pagoni et al. (2022), who conducted a detailed review of existing European regulation and policy frameworks. As a result, they found that more case studies are required to identify potential challenges within that space. Through interviewing the major MaaS platforms in Europe and asking them about policy and regulation barriers, three observations emerged; *Inconsistent Regulation and Legal Requirements Pose Challenges to MaaS Providers*, *Reaching Critical Mass is Challenging Because Of Limited Funding* and *High Volatility and Multi-Modal Liabilities Pose Challenges for Regulation*. The following paragraphs discuss the patterns of these observations together with inductive codes.

6.4.1 Inconsistent Regulation and Legal Requirements Pose Challenges

The first observation is that inconsistent regulation and legal requirements challenge to MaaS providers. This observation emerged from analysing the patterns of Kamargianni and Matyas (2017), Tabascio and Brail (2022), Karlsson et al. (2017). The patterns originate from the barrier themes PR2 and PR3, which address legal and regulation barriers.

Addressing legal frameworks, Kamargianni and Matyas (2017) highlighted the need for MaaS providers to have legal agreements and frameworks in place.

Evidence of this thesis revealed that municipal and international laws bind MaaS providers, “we are also bound by municipal law […], everything we do must have a relatively direct connection to (our city)” (I1). That suggests that navigating these complex legal landscapes has been a significant challenge for MaaS providers.

Conversely, Tabascio and Brail (2022) pointed out the need for governments and cities to better understand the local and regional regulatory implications of MaaS. However, the findings indicated that cities often have very little regulative power for MaaS: “our regulations or laws can’t allow the city to say you can’t operate here, you can park the bikes here” (I14). What is clear is that a more harmonised and understandable regulatory approach is needed to facilitate the implementation of MaaS.

Within this context, Karlsson et al. (2017) expressed the need to create governance frameworks on macro and meso levels. However, such frameworks stay future topics as the problem lies in formulating those frameworks. In particular, evidence showed that even if frameworks do exist, they are insufficient. One factor is that some participants wished to regulate more, “there is very little regulatory power” (I18). In contrast, others made it clear not to overregulate “If there were legislation or, you know, even guidelines that said that’s not a standard you’re not really allowed to do, that might be prohibitive” (I5).

These findings show that MaaS and its technology are still in the early stages. The ‘product’ of MaaS is still emerging, resulting in a learning process for the MaaS providers, users, and regulatory and legal institutions. As a result, things must be constantly tried and re-evaluated, demanding a flexible policy or regulation. The actors of the MaaS ecosystem need to develop as a basis for such discussion their code of practice with success measures.

Still, specific legal questions need to be determined as they newly arise. One code inductive emerged has been a liability, which will be discussed in the context of multi-modal liabilities in the third observation. In conclusion, inconsistent regulation and legal requirements pose significant were found to cause major barriers to MaaS providers in establishing their MaaS platforms. As a result, MaaS providers need to learn how to navigate through complex municipal and international laws, dealing with inconsistent regulations across different regions. A lack of comprehensive and consistent regulatory frameworks demands a flexible approach to formulating these.

6.4.2 Reaching Critical Mass is Challenging Because of Limited Funding

The second observation is that limited funding makes reaching critical mass challenging. This observation emerged from analysing the patterns of Kivimaa and Rogge (2022) and Smith and Hensher (2020) and the inductive codes of *Critical Mass* and *Funding*. The patterns originate from the barrier theme PR3, which addresses policy and regulation challenges.

Especially the previous observations in the social and cultural area have shown that reaching a critical mass in MaaS platforms is a challenging task. One aspect of being able to reach a critical mass is that the MaaS platform is funded. In the initial development stages of a MaaS platform, capital funding plays a significant role: "our funding is capital funding, so it's fine for upfront development costs" (I10). This type of funding has allowed MaaS providers to cover the initial costs associated with developing their platforms, including technology development, infrastructure set-up and market research. However, securing sufficient funding for ongoing operations has been a barrier to many MaaS providers, "a lot of them are struggling or at least having trouble finding enough capital for their operations" (I13).

These findings made it clear that the funding strategies need not only to pay the upfront development costs, but the MaaS providers need to develop viable and sustainable funding models for long-term success. However, most MaaS providers could only secure the funding to cover the initial development costs but often fail to secure sustained funding. One reason for that has been the barrier to creating business models. This has been confirmed and emphasised by the participants: "I think the business model was quickly lost and that's why not everyone can afford to set up such a platform" (I7).

This indicates that the key challenges besides funding include establishing a critical mass on the user side, resulting in a viable business plan. These findings of this study align with Mulley and Nelson (2020), who state that the business model discussion is still in an early stage. Many strategies have been suggested in the literature to overcome this funding situation. For example, Kivimaa and Rogge (2022) suggested that short-term experimentation should inform long-term institutional change. This study interviewed many MaaS platforms which are in the process of establishing themselves and are in pilot phases. It became evident that with the short-term experimentation of building those platforms, the providers could make senior decision-makers and politicians understand and buy into the concept of MaaS: “we got them, or forced them, to think about a mobility strategy for the city” (I2).

This finding suggests that initial experimentation with pilots helps to build the necessary political support, which then facilitates long-term policy changes. Such long-term policy changes are required for suitable investments to make MaaS a reality. In this context, Smith and Hensher (2020) argued that long-term objectives are needed to overcome such institutional barriers.

However, the findings indicated that the lobby of the automotive industry is strong, and politicians often tend to think in political cycles: “politicians having a go against the motorist is not politically viable” (I8). Thus, the findings indicate that while long-term objectives and funding are crucial for the success of MaaS platforms, they can be challenging to implement due to the influence of the powerful automotive lobby and the short-term decision-making caused by political cycles.

In conclusion, achieving critical mass in MaaS and securing sustainable funding requires short-term experimentation to gain political support. This procedure must be followed by long-term goals to overcome institutional barriers. However, the study results showed that such efforts are hampered by limited funding, lobbies' influence, and the short-term focus of political cycles. Therefore, MaaS platforms must demonstrate their value and be better anchored in cities' mobility strategy.

6.4.3 High Volatility and Multi-Modal Liabilities Pose Challenges for Regulation

The third observation that emerged detected that *High Volatility and Multi-Modal Liabilities Pose Challenges for Regulation*. This observation emerged from the pattern of Arias-Molinares and García-Palomares (2020) and the inductive codes of volatility of the market and liability. The pattern mainly emerged from PR3, which addresses poor governance frameworks.

The previous observations showed that inconsistent regulations and limited funding are critical barriers to creating policies or regulations for MaaS. This observation outlines factors that emerged from the data which make regulation of MaaS platforms challenging. One factor also named previously was the high volatility of the market.

Participants outlined that especially because of the volatile market, it has been a challenge for them to keep their offering up to date: “we always keep the offers up to date because the market is very volatile and many offers enter the market, leave the market” (I2).

Looking at potential regulation, Arias-Molinares and García-Palomares (2020) indicated that regulation could inhibit the ability of the private sector to innovate. From the findings, it becomes evident why this is the case. The MaaS ecosystem, and therefore the market, is so dynamic that once a policy is defined, it is already out of date. For this reason, participants amended that too much regulation will lead to unattractive MaaS: “the regulations that are based on the rules that have been set up in an area are also hurdles under certain circumstances” (I7).

Still, Kamargianni and Matyas (2017) emphasise the need for MaaS providers to have legal agreements and frameworks in place. Again, the findings underscored the importance of that. The reason was that such legal agreements and frameworks need to detail important aspects like multi-modal liabilities. For example, one participant reported major fraud cases inside their MaaS platform: “we had quite significant cases of fraud, which were often carried out via an MSP” (I2).

As a result of that, clear responsibilities are especially needed for multi-modal liabilities when multiple actors are involved. At the same time, traditional operators must move away from their no-risk policies towards a state where a calculated business risk is accepted. Evidence shows that the successful MaaS providers took risks: “we as company also took a certain risk, because we wanted to go out” (I3).

However, the evaluation also revealed that legal frameworks do not always facilitate the development of MaaS platforms. For some participants, these legal requirements even delayed their delivery due to the need to comply with international laws.

Furthermore, participants stated that not all legal requirements were clear. Thus, the legal complexity of MaaS underscores the need for politicians and senior decision-makers to ensure that policies are formulated to be understood and adopted by MaaS providers. Especially integrating MaaS into understandable societal goals can provide new avenues to overcome these barriers.

Table 45 concludes the discussion around policy and regulation barriers and depicts data excerpts supporting the discussion around the observations.

Table 45. Thematic Data Excerpts Supporting the Observations Discussion of Policy and Regulation Barrier Patterns

Data Excerpts	Emerging Observations from the Patterns
1) *"If there were **legislation** or, even **guidelines** that said that's not a standard you're not allowed to do, that **might be prohibitive**. I think with legislation and standards **you need to be careful** […]. It could be a double-edged sword." (I5)*	**Inconsistent Regulation and Legal Requirements Pose Challenges to MaaS Providers** **Supporting Patterns**: 1) Tabascio and Brail (2022) 2) Kamargianni and Matyas (2017) 3) Karlsson et al. (2017)
2) *"The **regulations** that **are based on the rules** that have been set up **in an area are also hurdles** under certain circumstances." (I7)*	
3) *"From the policy and legislative perspectives, it is very hard and would **not work if the legislation is too detailed** or legislates only one or two models because it would not work in every place." (I4)*	
1) *"When you have the **critical mass** of mobility providers then others will definitely want to be part of it." (I6)*	**Reaching Critical Mass is Challenging because of Limited Funding** **Supporting Patterns**: 1) and 2) Kivimaa and Rogge (2022) 3) Smith and Hensher (2020)
2) *"We had applied for **funding** from the federal government […]. However, these are usually **limited in time**, with funding usually limited to one or two years." (I1)*	
3) *"A lot of them are struggling or at least having **trouble finding enough capital for** their **operations**." (I13)*	
1) *"First of all, the **market is dynamic**, so on the one hand players appear, but players also disappear again." (I2)*	**High Volatility and Multi-Modal Liabilities Pose Challenges for Regulation** **Supporting Patterns:** 1), 2) and 3) Arias-Molinares and García-Palomares (2020)
2) *"I do see the **volatility** as a major challenge, for example the fact that, how should we put it, the ownership structure likes to change, but so do the **business models**." (I1)*	
3) *"So, I've had or been in situations where we're working on a city-based project and the city said, well, we'll collect the money, but we're **not taking any responsibility for fraud**." (I5)*	

6.5 Deriving Success Factors from the Observations

This section provides a design-oriented discussion detailing the “so what” from the barriers in the MaaS business ecosystem. For that, the barriers concerning the observations of the previous section are synthesised, and success factors, together with empirical data, are presented and discussed. Therefore, this managerial discussion presents the practical contributions of this thesis. These are mapped back to the previously discussed observations and more interview data. Table 46 presents the overarching success factors linked to observation inductively from the discussion chapter. For each observation, a success factor emerged. The success factor for each observation does not need to be in the same thematic area. For example, the observation can target technology and data, but the success factor is in the social and cultural space.

There are three technology and data success factors. The first is about formulating a clear solution strategy that can be integrated (inter)nationally and targeted locally. The second is about co-creation and exchange bodies, and the third is about learning commercial agreements and rule books.

The social and cultural success factors include customer research and best practices, establishing a code of practice with success measures and strong branding and communication.

Policy and regulation success factors include concessions and obligations, anchoring MaaS, getting political buy-in, and integrating MaaS into societal goals.

The following paragraphs discuss each success factor and map the observation patterns while being examined with empirical evidence.

Table 46. Overarching Success Factors linked to Observations and Outcome

Success Factors (SF)	***Linked Observations***	***Discussion Outcome***
Technology and Data Success Factors		
(SF1) Clear Solution Strategy: Integrate (Inter)nationally and Target Locally	*Unique Platforms Hinder Standardisation and Interoperability*	Clear rules help the integration and enable regulation.
(SF2) Co-Creation and Exchange Bodies	*The Need to Modernise Traditional Actors is Causing High Integration Efforts*	It helps to streamline the development and establish an exchange.
(SF3) Lean Commercial Agreements and Rule Books	*Reliance on DSPs Poses Architectural Challenges to MaaS Providers*	An easy, fair, and understandable contract helps development.
Social and Cultural Success Factors		
(SF4) Customer Research and Best Practices	*Need to Foster User Acceptance Through Triggering Behavioural Change*	Helps to overcome demand-driven and technical barriers.
(SF5) Code of Practice with Success Measures	*Need for Building Trust through Collaboration and Championing MaaS*	Increases diffusion by creating soft-law measures.
(SF6) Strong Branding and Communications	*Need to Build Up Technical In-House IT Skills*	Trusted brands increase user adoption and trust in the ecosystem.
Policy and Regulation Success Factors		
(SF7) Concessions and Obligations	*High Volatility and Multi-Modal Liabilities Pose Challenges for Regulation*	It helps to regulate MaaS by issuing licenses and obligations to modernise interfaces.
(SF8) Anchoring MaaS and Political Buy-In	*Reaching Critical Mass is Challenging Because of Limited Funding*	Anchoring MaaS in the mobility strategy of cities amplifies development of it.
(SF9) Integration into Societal Goals	*Inconsistent Regulation and Legal Requirements Pose Challenges to MaaS Providers*	Streamlines development and helps to secure funding by integrating into societal goals.

6.5.1 Deriving Technology and Data Success Factors

(SF1) Clear Solution Strategy: Integrate (Inter)nationally and Target Locally

Table 47 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 47. Discussion Outcome of Clear Solution Strategy

Success Factor	*Mapped Barriers*	*Discussion Outcome*
Clear Solution Strategy: Integrate (Inter)nationally and Target Locally *This success factor addresses barriers in the technology and data space by defining a clear solution strategy that integrates globally but targets the users locally.*	➢ Data Security and Privacy (TD1) ➢ Lack of Openness of Data, Standardisation, Data Silos and Interoperability (TD2) ➢ Unclear or No Platform Architectures Existing (TD4)	Participants report that setting out a clear solution strategy with defined features that enable regulatory frameworks was necessary. The rule of thumb should be integrating actors on clear rules nationally while targeting the users locally.

The patterns show that a clear and unified solution strategy for the MaaS providers is required to develop a MaaS platform successfully. The participants with different strategies have achieved such a clear solution strategy. I10 achieved that by iteratively developing the product in order to be able to “develop something which we can show” (I10). I9 adopted a similar strategy, focusing on meeting all the requirements and persuading the other actors to adopt the following features as part of the solution strategy. I9 clarified “what the advantages are and what the disadvantages are and where they might be at a competitive disadvantage if they do not make certain adjustments” (I9). An important strategy followed was to offer the latest features while breaking down barriers to using the platform.

For example, I16 indicated that especially “contactless being the token for travel” (I16) and focusing on “reducing barriers to access to services” (I16) had been critical points in their solution strategy. For I1, the solution strategy included setting up “our own ticket shop for public transport ticketing […] and a single sign-on” (I1). Another example of a solution strategy was the one of I5, which supported smaller community providers to build their APIs, “a small internal API that allows our platform to be able to check operating times” (I5). Such clear solution strategies are the basis for developing regulations. There is a common understanding that such regulatory frameworks should not be too detailed to meet the needs of different cities and rural areas (I3, I5, I11). Establishing a policy at the EU level is seen as hard to achieve, as “different kinds of member states have different kind of cities” (I4). Thus, formulating an overarching regulation is complex. As a result, the common sense is that regulation needs to first happen within the cities following national legislation (I1, I3). However, it needs to be made sure that the “regulations in the cities actively allow this and do not somehow artificially limit it” (I3). Thus, I13 suggests “integrate nationwide […] and target your travellers, local or regional” (I13). In this context, one idea is about certified MaaS providers, which are certified based on all the regulatory requirements for a particular area. In conclusion, a straightforward solution strategy can be seen as the requirement for developing regulatory frameworks, integrating actors on clear rules nationally while targeting the users locally.

(SF2) Co-Creation and Exchange Bodies

Table 48 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 48. Discussion Outcome of Co-Creation and Exchange Bodies

Success Factor	*Mapped Barriers*	*Discussion Outcome*
Co-Creation and Exchange Bodies *This success factor shows the need to co-create the MaaS solution to amplify the learning process and establish exchange bodies to discuss ideas and collaborate.*	➢ Competition, Losing Monopoly Position, Control and Influence (SC2) ➢ Missing Collaboration (SC4) ➢ Legal Issues, Bureaucracy and Institutional Barriers (PR2)	Participants report that co-creation helps to streamline development and modernisation. Further, it can be derived that there is a need to establish exchange bodies where all actors come together to discuss the development of MaaS.

The implementation of MaaS platforms requires new forms of cooperation between the different actors to achieve the integration of different mobility services. This success factor reports co-creation and the formation of exchange bodies. Co-creation in this context means that the different actors must create the solution together because of the continuously changing functionalities and requirements for a MaaS platform. I3 reported that through close co-creation with the DSP, they could develop "individual price models, depending on which third-party platform they connect to" (I3). Thus, co-creation amplifies the learning process for all the actors involved in the solution. In addition, I18 thinks that if the MaaS solution is "co-developed between government and the public sector and the private sector […]. That could be good at streamlining how this is delivered" (I18). Co-developing also means offering help to modernise APIs. I3 mentions that "we also offered to help them make their APIs ready, be it with technical know-how or with financial support" (I3).

For the more extended ecosystem influencing the development of MaaS, all actors must come together to discuss the development of MaaS. To exchange ideas and to collaborate on MaaS, forums and industry events were found to be essential (I3, I5, I9, I15).

For example, I3 states they “meet each other at industry events where we can exchange ideas” (I3). In such events, they brought all concerned MSPs to a table and discussed new ideas about the platform's functionality. I3 underlines the atmosphere had always been positive “you always felt a goodwill and openness from all the participants” (I3). I15 progressed with such events even further, establishing “a meet-up of 14 different cities around the UK” (I15) to exchange ideas and learnings. I5 emphasised the importance of such meetings being physical “in the same room” (I5) as a success factor. In contrast, I2 mentioned that they involved one actor via the information channel, which “turned out to be a serious disadvantage or an important learning” (I2). Thus, establishing such exchange bodies also was a success factor for I9.

Being “in exchange with all mobility providers” (I9) through active partner management helped them to build a successful MaaS platform. These closer relationships with all actors involved also helped I3 to establish a close relationship with decision-makers, creating a lobby for MaaS. Thus, co-creation and establishing exchange bodies are essential success factors for operating a MaaS platform.

(SF3) Lean Commercial Agreements and Rule Books

Table 49 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 49. Discussion Outcome of Lean Commercial Agreements and Rule Books

Success Factor	*Mapped Barriers*	*Discussion Outcome*
Lean Commercial Agreements and Rule Books *This success factor shows the need to establish lean commercial agreements and rule books to set out consensus amongst the actors in the MaaS business ecosystem.*	➢ Demand Estimation, Creation of Business Models, Tailoring of Services (PR1) ➢ Legal Issues, Bureaucracy, and Institutional Barriers (PR2)	Participants report that practising the contractual part of MaaS has been vital, resulting in lean agreements. Further, rule books can provide soft law measures to enable the concept.

Implementing lean commercial agreements and rule books for a MaaS platform can offer several benefits and thus is a success factor. I1 used the commercial agreement with a DSP to understand and “practice the contractual constellation in the background” (I1). Another case arranged an intelligent agreement with a DSP to help them build their MaaS offering by experimenting with city resources (I6). This had been a “sandbox for their product, which was tuned with our policy” (I6). Such an approach can be seen as valuable learning to streamline the development of MaaS in the cities.

Another meaningful learning was to address the complexity of commercial agreements. These must be kept as simple and lean as possible to facilitate the launch of MaaS platforms. I13 says they have developed “a template for the agreement” (I13). Through such a template agreement, the process of integrating new actors can be simplified and thus sped up.

According to I11, such a template should include a cost-benefit analysis so that "when you are introducing new functionality into your application […], we can do that more effectively" (I11).

In addition, to keep the number of commercial agreements lean, multiple cases adopted the strategy of closing commercial agreements with aggregators rather than individual actors (I5, I11):

I5: "we would much rather work with what we call a transport aggregator than the individual transportation."

I11: "we try to somehow do that more effectively and integrate one platform, which already includes six players."

Working with aggregators also helps to ensure data privacy, as the data can be reduced to the necessary information (I5). The so-called rule books are developed among the actors in the business ecosystem. Those rule books are "soft law measures, how to enable that data sharing, but not setting it in a legislation level" (I4).

Thus, rule books enable the actors to create their own rules, improving the corporation between the different actors in the MaaS business ecosystem. More research on how to realise such rule books is needed.

6.5.2 Deriving Social and Cultural Success Factors

(SF4) Customer Research and Best Practices

Table 50 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 50. Discussion Outcome of Customer Research and Best Practices

Success Factor	*Mapped Patterns*	*Discussion Outcome*
Customer Research and Best Practices *This success factor shows the need to conduct thorough customer research and actively look for best practices to make the MaaS platform successful.*	➢ Technology And Data Barriers (TD1-TD4) ➢ Acceptance of Users, Travel Behaviour and Lack of User Trust (SC1) ➢ Difficulties for Users Related to Technologies (SC3)	Participants report that customer research and best practices helped them overcome technical but demand-driven barriers. While some best practices are available, more are needed.

When developing a successful MaaS solution for a city or a region, customer research and best practices can help make the project successful. Evidence from the cases revealed that developing a list of relevant transport modes is an essential first step (I2). This list should then be prioritised through market research. This ensures that the right customers are targeted and use the selected transport modes. For example, I2 asked, “what would you like to have?” (I2). This helped form the construct of bundling the participating public companies and MSPs into one company.

In addition, I15 highlights that many decisions in public companies are made based on opinions. Thus, I15 notes that through customer research, “we’ll have more customer evidence on which to base decisions and move away from it being people’s opinions” (I15).

I11 states they “ask the clients and have surveys and focus group meetings” (I11) to prove their hypothesis and approach. As a result, customer research can inform the decision-making of the MaaS companies.

Besides customer research, best practices or references can be beneficial for learning from the experiences of other cities and regions. As many cities and companies in Europe are currently working on similar projects, it is worth talking to them and thus learning from their success and mistakes (I12, I14). However, I14 reports that there “are cities with similar systems but different approaches and developments” (I14). Still, I12 outlines that it makes sense to talk to them as their approaches and methods “we try to talk with them, and we try to learn from their failures and their achievements” (I12). Detailed customer needs and successful models from other cities and regions are needed.

(SF5) Code of Practice with Success Measures

Table 51 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 51. Discussion Outcome of Code of Practice with Success Measures

Success Factor	*Mapped Patterns*	*Discussion Outcome*
Code of Practice with Success Measures *This success factor extends the key learning rule book with information about business models and clearly defined targets that can be measured.*	➢ Demand Estimation, Creation of Business Models, Tailoring of Services (PR1) ➢ Poor Governance Frameworks, Policy and Regulation Challenges (PR3)	Participants report that a code of practice with success measures can help to co-develop new policies, regulations, or technical standards. Thus, the diffusion of MaaS platforms can be increased, and a more extensive marketplace for everybody can be established.

A Code of Practice with Success Measures can be used to formulate regulation. A code of practice sets out clear objectives, forms of working together and “soft laws” which are set by the participating actors in the MaaS business ecosystem. Thus, they extend rule books and should include “what do you want on paper, what do you want to control […] and how do we finance MaaS?” (I2). Further, a code of practice should contain procedures for “data or software integration” (I2). These procedures formulated in the code of practice must have success measures (I8). For that, clear targets and indicators should be defined. One example is measuring the number of open APIs following a particular standard or the number of platform functionalities other network actors can access. Another example includes reforms set out by the actors that enable “contactless becoming adopted as the standard-size token for travel” (I16). Such procedures can create “a bigger marketplace for everybody” (I8).

Further, through developing a code of practice and co-developing policy, regulation, and technical standardisations, the diffusion of MaaS platforms and technology can be increased. The critical point is that such a code of practice needs to be inclusive and “fair on the competition point” (I18). Market analysis and government consultation can further help to refine such a code of practice and identify points that could be improved through policy or regulation.

By working together, the government and legislation can then be informed by the participating actors to develop regulations and technical standards to enforce laws finally. I18 underpins that by saying, “we are collecting more information that we will send to the government on areas where we have seen challenges that we think policy or regulation could help develop” (I18).

(SF6) Strong Branding and Communications

Table 52 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 52. Discussion Outcome of Strong Branding and Communications

Success Factor	*Mapped Barriers*	*Discussion Outcome*
Strong Branding and Communications *This success factor indicates the need for a strong branding and communication strategy for the MaaS offering.*	➢ Acceptance Of Users, Travel Behaviour and Lack Of User Trust (SC1) ➢ Missing Leadership and Vision (SC5)	Participants report that well-known brands are trusted more by ecosystem actors. Positioning the platform and a marketing and communication strategy becomes a success factor in building a MaaS offering.

Strong branding and effective communications are critical to developing a successful MaaS offer. Evidence shows that well-known brands are usually first approached by potential users and other actors in the network. I7 emphasises that by saying those “who already had a certain reputation somewhere, who had a certain size, they were simply the first ones to be spoken to” (I7). Thus, it becomes increasingly important to position the brand when building a MaaS solution. I9 recognises a MaaS platform as an “opportunity to push us as a brand” (I9) while acknowledging that this includes using employees and decision-makers to spread the word. One example is that the CIO of I9 “was named the CIO of the year” (I9), being very visible throughout the industry. In addition, active partner management helped to increase the brand and make others aware of the MaaS solution.

Besides increasing the branding of the MaaS company, marketing communications have been reported as critical by the participants (I2, I10, I11, I12, I17).

In this context, I10 underlines the importance of allocating a budget for communication activities: “you cannot underestimate how much you must do for a MaaS product to be successful and, yes, you need a big budget for the Marcoms piece” (I10). Further, I10 suggests using the digital expertise of “the technology providers if they have good experience with Marcoms” (I10). One specific example can be the communication of success stories, “everybody loves success stories” (I11). I17 sees the most extensive learning around convincing people to give up their usual means of transport in favour of using the MaaS platform. Therefore, I17 sees the need to educate people through communications to “encourage people to start using the platform” (I17). The I12 strategy is to “explain the advantages” (I12). For that, social media advertising, including campaigns, was adopted, and “we reacted to that with campaigns and advertising measures” (I17). One example of that is “targeted emails and local business campaigns or mobile notifications” (I17).

In conclusion, strong branding and communication are essential success factors towards an effective MaaS platform.

6.5.3 Deriving Policy and Regulation Success Factors

(SF7) Concessions and Obligations

Table 53 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 53. Discussion Outcome of Concessions and Obligations

Success Factor	*Mapped Patterns*	*Discussion Outcome*
Concessions and Obligations *This success factor addresses potential requirements for actors in the business ecosystem to offer their services.*	➢ Modernisation of ICT Infrastructure, Internet Coverage, and Real-Time Information Available (TD3) ➢ Competition, Losing Monopoly Position, Control and Influence (SC2) ➢ All Policy and Regulation Barriers (PR1-PR3)	Participants report that concessions in the form of licenses can help to regulate mobility in a city and that through obligations, actors are required to modernise or open up their interfaces.

Another success factor the MaaS platform providers observe is concessions and obligations. Concessions and obligations are essential requirements for potential regulations as they encourage the integration of different actors into the MaaS platform. A concession in this context means that the city issues a license through regulation followed by the "demand integration into the municipal platform" (I1). Thus, if a company wants to offer mobility services in a city, it "needs to have such a license" (I13). This is also shared by I9, emphasising the need for an "obligatory to integrate into our municipal platform" (I9). According to I1, this helps to "get a grip on this permanent volatility" (I1). A provider with such a license is considered a "certified MaaS provider" (I13). With being a certified MaaS provider, there comes the obligation to offer "digital tickets for the third party" (I4). This must be required to sell the "digital item through multiple channels" (I4).

That means the city can regulate a particular company's products through concession or license. Such regulation has already started through reforms in some countries.

For example, I5 reports that if bus providers "are of a certain size, they have to provide their information with their routing information, their placing information, and their timetable information to a national service" (I5). Another example of an obligation is the city of Antwerp which requires scooter and bike-sharing providers to integrate "with at least three MaaS operators" (I13).

Besides individual regulation of cities, also government can legislate the obligation to integrate into MaaS solutions. One example of that has been the Finnish government, that "put in a law that said every organisation, or certainly the public transit, had to open their APIs for supplier" (I8). However, in this context, it was essential to ensure that the APIs were open and easy to integrate (I8). Even without concessions, I10 and I5 emphasise writing those obligations to integrate or open the APIs into the tender agreements.

In summary, concessions and obligations are essential to formulate regulation leadings towards successfully integrating MaaS actors into a platform.

(SF8) Anchoring MaaS and Political Buy-In

Table 54 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 54. Discussion Outcome of Anchoring MaaS and Political Buy-In

Success Factor	*Mapped Patterns*	*Discussion Outcome*
Anchoring MaaS and Political Buy-In *This success factor shows the importance of anchoring MaaS closely to the regional context and getting political buy-in.*	➢ Demand Estimation, Creation of Business Models, Tailoring of Services (PR1) ➢ Legal Issues, Bureaucracy, and Institutional Barriers (PR2) ➢ Poor Governance Frameworks, Policy and Regulation Challenges (PR3)	Participants report that anchoring MaaS in the cities' mobility strategy has been crucial for success. In addition, the MaaS providers must build close relationships with city officials.

Anchoring MaaS and getting the political buy-in are critical success factors in creating a MaaS platform. Through evidence of the MaaS platforms, the MaaS providers convinced the municipality with facts that MaaS is a practical "toolbox for the city or for the public sector to design transport the way they want it" (I2). Thus, through the evidence generated by the MaaS city platforms, it was possible to anchor MaaS in the city's strategy. One way for anchoring had been for I9 to establish "a physical mobility station network in the city" (I9). Such a physical network can also enhance the "engagement with what we call trip attractors" (I18). That means engaging with organisations creating many trips, for example, event companies organising sports or concert events. Another strategy had been to create a continuous interest procedure. I9 describes this as "a kind of call for tender that we have continuously published and also update" (I9).

This tender procedure makes it politically opportune for the providers to "get in touch with us, no matter what the outcome is" (I9). However, such strategies have only been possible because of political buy-in. To convince the politicians, early engagements explaining the model and building the case have led towards "MaaS is now seen as a positive opportunity for the authority" (I18). As a result, I18 describes the success factor as having the buy-in from "the low-level up to the chief executive and the mayor of the region" (I18). By listening, informing, and addressing their concerns, these stakeholders trust that a MaaS implementation can benefit the region. I6 adds that "a liberal mayor that had invited businesses to create and innovate […] fostered MaaS in many ways" (I6).

In summary, it can be concluded that not only can the MaaS provider alone drive the success of a MaaS platform, but it is also essential that the city officials and region are involved in building the MaaS platform to ensure its success.

(SF9) Integration into Societal Goals

Table 55 presents the discussion outcome of this success factor. After that, the discussion is detailed.

Table 55. Discussion Outcome of Integration into Societal Goals

Success Factor	*Mapped Patterns*	*Discussion Outcome*
Integration into Societal Goals *This success factor suggests i*ntegrating *MaaS into the societal goals of the cities, regions*, *or countries.*	➢ Legal Issues, Bureaucracy, and Institutional Barriers (PR2)	Participants report that by integrating MaaS into societal goals, several funds or consortiums can be formed to help streamline the development. Further, it can promote and help to shape mobility strategies.

Integrating MaaS into the cities' or countries' societal goals is crucial to formulating effective regulation. For example, I13 mentions that “societal change may be triggered by the government to say, here’s a fund, there’s a consortium” (I13). Through providing such a fund or consortium, the MaaS provider could apply to those helping to streamline the development. I15 has mentioned one example of such an act called the “well-being of future generations act” (I15). This act is “a piece of social legislation that ensures that we do our best for the next generation of people in (city) from an environment perspective, preserving culture […], it basically frames our policy goals” (I15). Integrating MaaS into such societal goals can thus help to shape a sustainable and liveable future for the next generation. One idea suggested by I13 had been that MaaS can not only be funded through integration with societal goals but also used MaaS as a tool to “fund the travellers to use sustainable modes of transport. The more sustainable the modes you use, the lower the amount of money you pay” (I13). Through that, the users of MaaS and the citizens are incentivised to choose environmentally friendly transport options.

I8 emphasises that in their region, they have already started with that. However, I8 says that “this is a much broader strategic question from a city, regional or country level to say we want to try to encourage more people to use more shared mobility” (I8). Starting with tiny steps, the MaaS project of I2 contributed “to think about a mobility strategy for the city” (I2). As a result, they included new passages about societal goals and data exchange in all new tender documents.

In conclusion, integrating MaaS as a platform into societal goals could help to create a better future by promoting more sustainable forms of transport and shaping the mobility strategies of urban areas.

6.6 Conclusion: ANT Patterns and the CABS Framework

This final section concludes on the ANT patterns of this thesis. For this, Subsection 6.6.1 concludes on the actor network and pattern findings by recapping the major gaps and using the translation moments of ANT. Subsection 6.6.2 finalises this chapter by presenting the Cases, Actor Networks, Barriers, and Success Factors (CABS) framework, which outlines the findings and contributions of this thesis.

6.6.1 Concluding on Actor Network and Patterns Findings

This subsection sheds new light on the previously discussed patterns by concluding how they helped to fill the research gaps and how ANT supported this endeavour. Revisiting the patterns discussed earlier, ANT has proven very effective in analysing them. Starting with the thematic areas, Christiaanse (2019) recognised and described MaaS services in three dimensions; technical, economic, and sociological. This thematic understanding of the barriers has been the basis for analysing the pattern findings of the previous sections.

Next, the major challenge was finding a conceptualisation and theoretical understanding to analyse the thematic patterns. In the literature, initial characteristics of MaaS and possible conceptualisations were proposed by Giesecke et al. (2016), Jittrapirom et al. (2017) and Kamargianni and Matyas (2017) (*see* Section *2.2.3*). These studies clarified that MaaS platforms must take an integrated approach and that gaps (represented through barrier patterns) in each area must be identified and filled. To do that, as Smith and Hensher (2020) outlined, a theoretical framework to conceptualise the MaaS business ecosystem was needed. This thesis proposed with ANT a novel conceptual understanding which helped to close the gaps for finding a theoretical framework and to conceptualise the MaaS business ecosystem.

Another central gap was the one of Haavisto and Mladenović (2020), who stated that “we have to recognise that transport research lacks both similar empirical studies, and lacks operationalised conceptual frameworks from philosophy and sociology of technology” (Haavisto & Mladenović, 2020, p. 857). By applying ANT and constructing the resulting actor networks, this thesis provided a conceptual framework that can be operationalised through translation moments. The following paragraphs critically discuss how ANT helped identify and amend the barrier patterns to understand better the actors' relationships inside the MaaS business ecosystem.

Problematisation

Concerning the problematisation, the findings of the different actor networks have confirmed the MaaS definitions and conceptual understanding of the literature (*see* Section *5.2.1*). In the context of the original problematisation described by Callon et al. (1983), particularly the concept of OPPs has been valuable because it enabled an understanding of how each actor in the network is connected to the focal actor, the MaaS provider (*see* Figure 28). This fact allowed to examine the relationships of the MaaS providers, including the barriers they faced. These relationships for each participating case have been formulated using the actor networks (*see* Section 5.1). Examining the relationships indicated that all cases differed in the background but shared similar goals. This finding matched the selection criteria as the cases were heterogeneous in their context but homogeneous in their objective. The objective of the cases was to trigger a mindset change, “convince people to change to public transport” (I11), and “strengthen public transport plus the environmental network” (I1). However, it turned out that the cities had different levels of maturity, which led to different barriers, even though they all belonged to the same thematic areas.

As many actors needed to work together to develop a MaaS platform, several barriers were experienced in the problematisation. Therefore, applying ANT in problematising and understanding these barriers has been instrumental.

Interessement

The interessement strategies of the MaaS providers to get other actors interested in joining their network varied. The reason for that is the diverse strategies the different participants applied to get other actors interested. Some participants had just started the project, while others operated a mature platform. However, the findings show that there is a need to focus better on the recruitment process. A successful MaaS platform provider experiences several social and cultural barriers in the interessement process. Especially barrier patterns in the space of missing collaboration (SC4), missing leadership and vision (SC5), and competition or fear of losing monopoly positions (SC2) were experienced (*see* Table 42). Successful interessement strategies included “meeting each other at industry events” (I3), tendering interest procedures “a kind of application procedure was advertised” (I1), outlining the benefits “we show them the potential” (I14) and creating exchange boards “we enacted some sort of a committee” (I6). These findings confirm that an actual recruitment process establishes roles and power relationships (Law & Callon, 1988). Especially in the context of this research, the process of getting other actors interested, demonstrated the barriers faced in the interessement phase.

Enrolment

The enrolment of actors has posed its own set of challenges for the MaaS provider. Depending on the maturity level, the cases either were in the initial expansion phase and established procedures, prioritised and funnelled new actors or were already thinking about the readiness and depth of integration.

This complexity of the enrolment process was shown through the barrier patterns, especially around technology and data (*see* Table 42). Specifically, barriers around the lack of openness of data (TD2), modernisation (TD3) and round platform architecture (TD4) were experienced in the enrolment process. This fact was underlined by one participant who noted that “there are of course technical requirements that must first be fulfilled” (I9). Another participant further highlighted the complexity of enrolling new actors: “integrating all public providers is tough. Every provider has a unique system; they have their own requirements and so on” (I14). The participants established different enrolment processes to inscribe new actors for their network to tackle those barriers. Enrolment in this context of the thesis showed that the other actors accepted the MaaS provider and their role in the network. For that, it can be confirmed that the concept of inscription by Sarker et al. (2006) plays a vital role in the actor networks of the participants. As a result, the first alliance formations were observed, indicating that the network translation has been successful (Alexander & Silvis, 2014). To conclude, it was successfully shown that enrolment is a process that happens inside the actor networks of the individual MaaS business ecosystems. Mainly the technological and data barriers underscore the complexities involved in the enrolment phase.

Mobilisation

The evaluation of the mobilisation activities in the individual actor networks revealed how the MaaS providers are planning activities to evolve their ecosystem. This procedure includes the establishment of MaaS champions and spokespersons who can advocate for MaaS and drive the implementation of a MaaS platform.

Again, it was demonstrated that the platform's maturity plays a significant role in this phase, influencing the strategies and activities undertaken. The major barrier patterns for this phase were in the social and cultural and policy and regulation space (*see* Table 42). Especially legal issues and institutional barriers (PR2), including the pattern of getting the political buy-in through short-term experimentation of Kivimaa and Rogge (2022), demonstrated the challenge of mobilising the MaaS ecosystem.

Further, it was shown that trust and branding of the platform are crucial factors in this phase. Here, the discussed concept of a certified MaaS provider can contribute to building trust and enhancing the platform's reputation. Another key has been the establishment of regional transport partnerships, which should include decision-makers, help to promote behavioural change and help to connect to societal goals. This finding is confirmed by the literature on ANT. One example is Burgess and Tatnall (2002) mentioning the possibility for actors to create individual sub-networks. The participants demonstrated this because they established different representatives. One significant finding of this thesis is that MaaS champions are vital in mobilising the actor networks. It became evident that betrayal or disbelieving in the network could be prevented by establishing MaaS champions and having critical stakeholders on board (Callon, 1984).

6.6.2 Presenting the CABS Framework

After discussing the barrier patterns of this thesis, this subsection concludes the chapter by presenting the CABS (Cases, Actor Networks, Barriers, and Success Factors) framework, which demonstrates the approach and details the contributions of this thesis. Figure 29 depicts the CABS framework.

The following paragraphs introduce the framework and demonstrate its application for this study.

The CABS framework offers a comprehensive and structured approach to understanding and analysing MaaS business ecosystems from the view of the MaaS provider. It consists of four steps: gathering Cases, applying Actor Network Theory with Actor Networks, analysing Barriers, and deriving Success Factors.

The first step of gathering cases involves screening and sampling the MaaS business ecosystem in its environment. Applied to this thesis, nine case studies based on 18 expert interviews were gathered and then used for within-case and cross-case analysis to understand the individual MaaS ecosystems.

The second step includes using ANT with actor networks to better understand the actors and their relationships within the MaaS business ecosystem. In this thesis, actor networks and the moments of translation helped to formulate and analyse individual cases for emerging barriers (*see* Section 5.1).

The third step involves investigating the barriers in three thematic dimensions. In this thesis, three themes with 13 subthemes were derived based on the insights of the actor networks. These themes were then evaluated and amended with empirical data to discover patterns (*see* Section 5.3). The barrier themes were then discussed by selecting key barrier patterns in this chapter.

Finally, the fourth step involves analysing the patterns to derive success factors that can help overcome the barriers. This thesis synthesised nine success factors based on the discussed barrier patterns (*see* Section 6.5). In addition, nine prospects for MaaS grouped for the barrier themes were derived, which project future avenues for MaaS researchers and practitioners (*see* Appendix J).

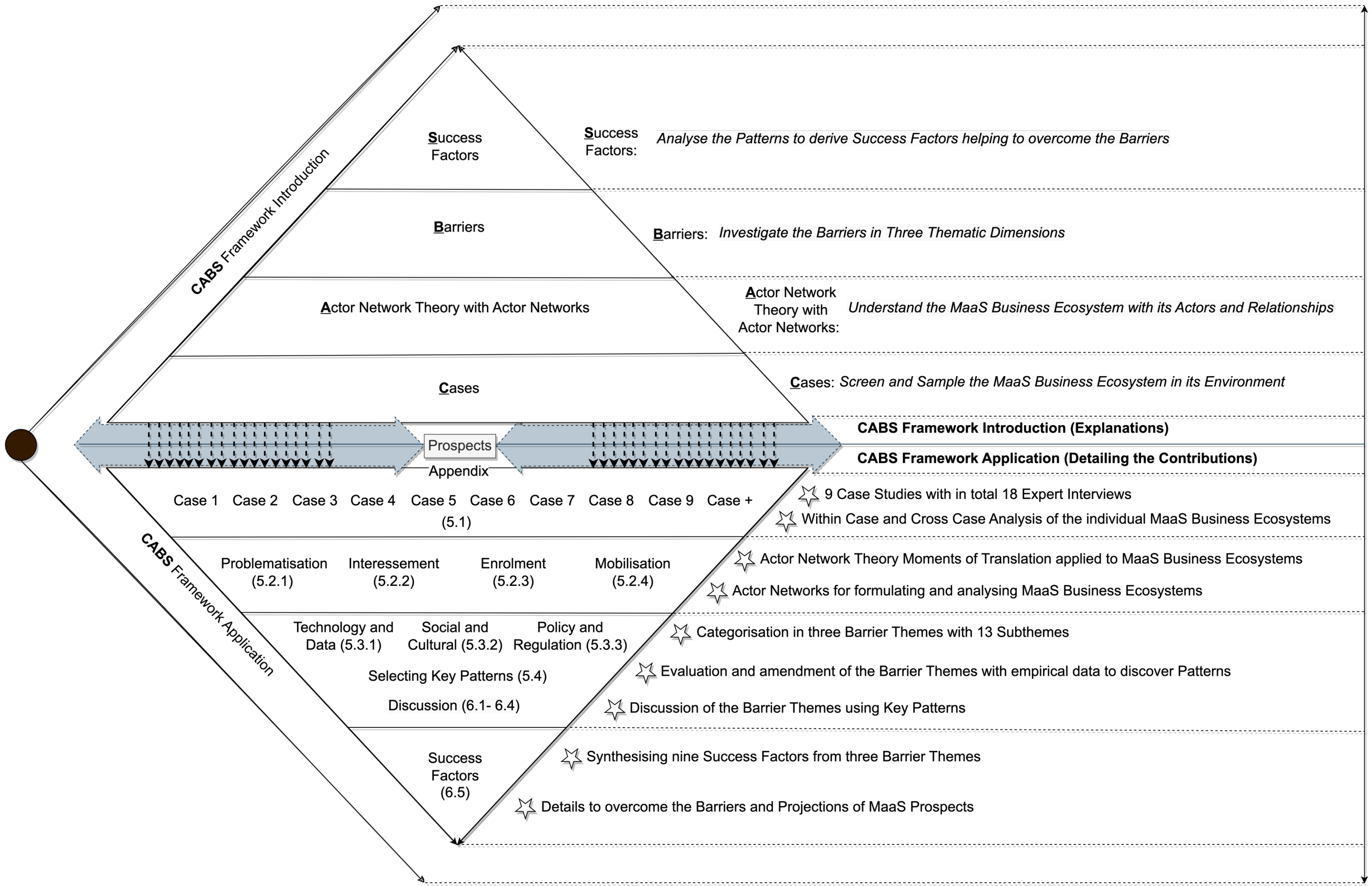


Figure 29. The Final CABS Framework

7 Conclusion and Reflective Commentary

MaaS platforms are becoming part of our daily lives, enabling citizens to consume mobility digitally. However, the MaaS provider faces many barriers while establishing such platforms. This research analysed what barriers are experienced by MaaS providers in building their platforms and their business ecosystem using ANT.

7.1 Introduction

Chapter 2 presented important concepts of MaaS, including setting out the conceptual understanding of MaaS by reviewing key literature in the field. In addition, the core concepts of ANT have been introduced, and it was shown how the MaaS business ecosystem can be conceptualised using ANT.

Based on the conceptual understanding and with ANT as the theoretical foundation, Chapter 3 performed an SLR on actors and their barriers in the MaaS business ecosystem. This SLR pointed out 16 different actors and three core barrier themes: technology and data, social and cultural and policy and regulation. Further, it identified literature gaps and created the first MaaS business ecosystem actor network based on the findings.

Chapter 4 introduced the research philosophy and methodology, including the ontological and epistemological assumptions. Through an interpretive lens, DSR, combined with multiple cases following the research procedures of Yin (2018), was chosen as the research design to analyse the experiences of MaaS providers. Based on that research design, the case study protocol was introduced, including the bounding of the case studies, the data collection procedures, and the analysis methods.

The cases and the participants were selected with explicit criteria, and empirical data from 20 MaaS experts were collected. Before the main study started, two pilot interviews verified this thesis's interview design and structure. After that, 18 interviews were conducted with MaaS experts, revealing their experiences building MaaS platforms.

Chapter 5 presented the research findings from the participants. The basis for this report formed the within-case reports. For the within-case reports, the interviews were logically grouped by their cases showing evidence of how individual MaaS platforms build up their MaaS business ecosystems. The findings were linked to the ANT translation moments: problematisation, interessement, enrolment and mobilisation. Nine cases were inspected, followed by an additional case presenting supplemental experiences from MaaS consultants and lawyers. After gaining those insights, the results chapter evaluated the cross-case actor networks and the barriers. This cross-case analysis used the insights of the previous phase to compare the findings on the different ANT phases across all cases. Here, the three main barrier themes from the literature were amended with the empirical findings. As a result, patterns were derived, and key patterns were selected for further discussion.

Chapter 6 discussed the key patterns through synthesising observations. These observations were discussed with the patterns by explaining why specific differences between the literature and the findings emerged. This was followed by the managerial discussion, which derived success factors to overcome the barriers. This chapter then concluded on the ANT patterns and presented the CABS framework.

Finally, the conclusions of the thesis are presented in this chapter. Section 7.2 summarises the research objectives. Section 7.3 discusses the contributions to the theory and practice of this thesis. Section 7.4 outlines the limitations of this thesis and presents directions for future research. Finally, Section 7.5 concludes this thesis by reflecting on the researcher's role and journey.

7.2 Conclusions to the Research Objectives

Three research objectives were investigated in this thesis: the first research objective developed a theoretical foundation, the second objective developed a design-based artefact, and the third objective amended the theoretical foundation and artefact with empirical findings from the interviews. The following subsections present each objective again, and conclusions are drawn.

7.2.1 Conclusion to Theoretical Research Objective 1

The first research objective was concerned with conceptualising MaaS and finding a theoretical lens to assess the MaaS business ecosystem further:

RO1: To explore the key elements, actors, and barriers of the MaaS business ecosystem at a conceptual level with ANT.

The purpose of RO1 was to identify the characteristics of MaaS and actors (building blocks) in the MaaS business ecosystem to generate an artefact later. To achieve that, first, an initial literature search was performed to review existing MaaS definitions. Based on these definitions, the characteristics of MaaS platforms were researched to better understand the concept of the MaaS platform. Here, the characteristics of Jittrapirom et al. (2017) and Giesecke et al. (2016) helped to define MaaS and revealed initial barriers existing in three thematic areas: Technology and Data, Social and Culture, and Policy and Regulation. In addition, the conceptual understanding of Kamargianni and Matyas (2017) has been used to further conceptualise this thesis's MaaS business ecosystem. The missing link discovered was ANT. With the help of the ANT concepts and the graphical syntax of Alexander and Silvis (2014), a first encounter of the MaaS business ecosystem actor network could be created using Kamargianni and Matyas (2017) as the basis. Initially, seven actors and their relationships have been conceptualised with this actor network delivering the input for the following research objective.

7.2.2 Conclusion to Design-Based Research Objective 2

The second research objective was designed-based. With the theoretical support of the first research question, this research objective investigated the MaaS business ecosystem closely.

RO2: *To map actors and barriers of the MaaS provider to derive the MaaS business ecosystem actor network.*

The purpose of RO2 was to examine the role of the human and non-human actors, their relationships, and the barriers they face in the business ecosystem. Here, an SLR was performed following the strategy of Okoli (2015) to outline the actors and their barriers. 791 articles were searched, and from these articles, 30 were included in the sample following the inclusion criteria and quality assessment. This corpus was then thematically coded for actors and barriers. As a result, 16 actors in the MaaS business ecosystem with their OPPs have been identified. In addition, the three barrier themes Technology and Data, Social and Culture and Policy and Regulation, were amended with subthemes (TD1-TD4, SC1-SC6, PR1-PR3).

These two results helped to generate the conceptual framework of this thesis by creating the second encounter of the MaaS business ecosystem. Finally, this artefact, the barrier themes, and the identified research gaps formed the basis for further empirical research.

7.2.3 Conclusion to Empirical Research Objective 3

The third research objective had an empirical basis. With the results of the previous RO2, the goal has been to conduct empirical research on the experiences of MaaS providers.

RO3: To critically analyse, evaluate, and synthesise the experienced barriers using the MaaS business ecosystem actor network artefact by conducting case study research.

The purpose of RO3 was to enable scholars and practitioners to identify case-specific barriers in MaaS implementations with the help of the MaaS business ecosystem actor network artefact and to formulate success factors to overcome these. For researching this, the Multiple Case Study approaches of Yin (2018), combined with the DSR of Hevner (2007), fit in this thesis's interpretive approach. An explicit case study protocol helped in that context to outline the selection criteria for the cases and the individual participants. This thesis focused on urban MaaS platform providers who are in a public private partnership and are operating in Europe. A semi-structured three-part interview guide was created to collect the data. With this guide, 18 interviews were collected and thematically coded for actors and barriers. To critically analyse the data, a within-case analysis was conducted. For this, the unit of analysis has been the individual cases meaning that the interviews were structured and analysed based on the individual cases (CS1-CS+).

This analysis showed how the individual MaaS cases develop their business ecosystem in ANT (Problematisation, Interessement, Enrolment and Mobilisation).

In addition, individual actor networks were created for each case using the artefact from the previous RO2 (*see* Section 5.1). This helped to complement the MaaS business ecosystem actor network and evaluate its use in practice. In addition to these findings, learnings, strategies, and future visions were outlined and critically analysed. This critical evaluation of the individual cases formed the basis for advanced cross-case examination of the interviews. The cross-case reports amended the barriers identified from the literature with the experiences of MaaS practitioners. First, a cross-case analysis of the actor networks was conducted to amend the actor network artefact. This included comparing and contrasting the ANT moments of translation across the cases. Next, the in-depth cross-case investigation of the barrier themes gave deep insights into the barriers experienced by the MaaS providers.

Further, it was shown that the barriers identified from the literature are widely represented in the empirical data. Besides these deductive barriers, the empirical evidence revealed inductive barriers for each thematic area. Next to the barriers, it was necessary to outline the success factors the different MaaS providers adopted to overcome them. These came up during the coding process and have been summarised and critically analysed in this thesis (*see* Section 6.5).

Finally, the RO3 was concluded by comparing the perspectives of the individual participants. This analysis revealed nine prospects mapped to the topics of the barriers (TDP 1-4, SCP 1-2 and PRP 1-3), which indicate how the MaaS business ecosystem will change in the future (*see* Appendix J). The analysis complements and evaluates the MaaS business ecosystem artefact using ANT and serves as a basis for further investigation.

As a result, the insights are relevant for researchers and practitioners in the field. Thus, the thesis statement "*it is possible to develop an MaaS actor-network artefact that analyses and examines barriers of the actors in the MaaS business ecosystem"* can be confirmed.

7.3 Contributions of this Thesis

This thesis contributed to the current body of knowledge and has managerial implications. It presented a novel approach to researching the barriers experienced by the MaaS provider in the MaaS business ecosystem. It closed the gaps of missing empirical evidence of MaaS platforms in the literature by providing in-depth empirical evidence of how MaaS providers build their business ecosystem. Thus, this research enhanced the understanding of barriers when building MaaS platforms. The following two subsections detail the contributions to the body of knowledge and the managerial implications of this thesis.

7.3.1 Contributions to the Body of Knowledge

This thesis contributed to the current body of knowledge in several ways. In this subsection, these contributions are detailed in the following paragraphs in accordance with the guidelines of Presthus and Munkvold (2016):

First, this thesis amended the literature by performing a systematic literature review on actors and barriers, accumulating insights from various MaaS studies (*see* Chapter 3). This resulted in 16 actors, which are the MaaS provider, Mobility Service Providers, Aggregators & Integrators & Brokers, Customers & Users, Technology and IT Providers, Ticketing and Payment Solutions, Dynamic Multi-Service Journey Planners, ICT Infrastructure, Insurance Companies, Regulatory Organisations, Investors, Universities and Research Institutes, Media & Marketing Firms, Unions, Entertainment Firms and the MaaS Champion (*see* Section 3.7.3).

All these actors are experiencing barriers, so the second part of the systematic literature review revealed barriers in the areas of technology and data, social and cultural, and policy and regulation. For each of these barrier themes, subthemes were identified (*see* Section *3.7.4*). Technology and data consists of *Data Security and Privacy* (TD1), *Lack of Openness of Data and Standardisation, Data Silos, and Interoperability* (TD2), *Modernisation of ICT Infrastructure, Internet Coverage, Real-Time Information Available* (TD3) and *Unclear or No Platform Architectures Existing* (TD4). Social and Cultural consists of *Acceptance of Users, Travel Behaviour and Lack of User Trust* (SC1), *Competition, Losing Monopoly Position, Control, and Influence* (SC2), *Difficulties for Users Related to Technologies* (SC3), Missing Collaboration (SC4*), Missing Leadership and Vision* (SC5) and *Skills and Knowledge Gaps* (SC6). Policy and regulation consists of *Demand Estimation, Creation of Business Models, Tailoring of Services* (PR1), *Legal Issues, Bureaucracy, Institutional Barriers* (PR2) and *Poor Governance Frameworks, Policy, and Regulation Challenges* (PR3). All these codes amended the body of knowledge. Further, patterns for these barrier themes were identified and discussed through observations (*see* Chapter *6*). These observations underscored the key barriers experienced by MaaS providers and were used to formulate success factors.

Second, this thesis added to the body of knowledge by presenting a novel conceptualisation of the MaaS business ecosystem using ANT (*see* Section 2.3). Here, the identified actors were discussed through the theoretical lens of ANT constructing the first MaaS business ecosystem actor network.

This actor network formed the basis for the empirical evaluation in this thesis, and it can be used for similar research projects in future.

Third, this thesis presented a novel research design to discover the barriers the MaaS provider experiences. This research design combined DSR with Multiple Case Study Research (*see* Chapter 4). This procedure enabled to develop the CABS framework, which offers a comprehensive and structured approach to understanding and analysing MaaS business ecosystems from the view of the MaaS provider (*see* Section 6.6.2). It includes four steps: gathering Cases, applying Actor Network Theory with Actor Networks, analysing Barriers, and deriving Success Factors.

Finally, based on the literature review, research gaps of missing empirical evidence and data on MaaS platforms by Haavisto and Mladenović (2020), Arias-Molinares and García-Palomares (2020) and Guyader et al. (2021) have been amended by providing interpretive evidence from 18 MaaS experts.

7.3.2 Managerial Implications

Besides the contributions to knowledge, this research has several implications for practitioners in the field. Additional participant feedback was collected to prove the relevancy of these implications, which is added to the respective managerial implications in the following paragraphs.

First, this research provided a conceptualisation of the MaaS business ecosystem and, thus, a framework for MaaS providers, decision and policymakers to map out their business ecosystem and contrast it against the theoretical findings of this thesis (*see* Section 5.1 and Appendix J).

This conceptualisation enables the practitioners to improve their MaaS services, amend this artefact or conduct more research with it in other contexts. Especially for companies and cities starting a MaaS platform or related developments, this thesis provides unique insights into the experiences of established MaaS providers.

Second, this conceptualisation, in combination with the empirical findings of the cross-case analysis of the barriers, contributed to practice serving as a fundament for more case-specific analysis to help practitioners to formulate new policies and regulations for MaaS (*see* Section 5.3).

Third, the observations from the discussion chapter lay the foundation for defining such policies (*see* Chapter 6). One observation showed that unique platforms hinder standardisation and interoperability. Feedback from one participant showed that he saw this as a key technical challenge and something that needs wider industry collaboration and leadership. Other observations showed that modernising traditional actors is causing high integration efforts and that many providers are still dependent on third parties, which leads to architectural challenges. Participant feedback indicated that they especially see the commercial model as a necessary implication to focus on. A good technical foundation thus fosters user acceptance and triggers behavioural change. Here, the observation outlined that collaboration and advocacy for MaaS are vital. Concerning this observation, participant feedback underlined that and stated that they started to develop a code of practice, which is also an identified success factor of this thesis (*Mobility as a Service (MaaS): Code of Practice*, 2023). The other observations revealed that inconsistent regulations and legal requirements add another layer of complexity. Here, overcoming funding limitations to reach a critical mass remains a significant challenge.

Participant feedback confirms that a long-term business model needs to be found to make the case for ongoing operation after public funding ceases. For that, the high volatility and multi-modal liabilities need to be addressed. All these observations can be used as insights to see what needs to be considered when building a MaaS champion and can be used to define success factors.

Fourth, success factors provide first-hand evidence and insights for practitioners. In this thesis, nine success factors were identified and connected to the observations, providing deep insights into the learnings of MaaS providers (*see* Section 6.5). The first success factor is having a clear solution strategy. This is particularly important to overcome integrating unique platforms and helps to establish clear rules that help the integration and regulation. Second, establishing co-creation and exchange bodies help modernise the traditional actors and streamline the development. Third, lean commercial agreements and rule books help to overcome architectural challenges if the MaaS provider is dependent on other market solutions as it helps to establish fair and understandable contracts. Fourth, customer research and best practices help to foster user acceptance as they mature the MaaS offering. Here, the study revealed the importance of good preparations, and developing a list of transport modes is an essential first step. Fifth, a code of practice with success measures helps to build trust and thus improves collaboration among the actors in the MaaS ecosystem. As mentioned earlier, this success factor is very relevant for the providers, as the participant feedback indicated that they have started working on a code of practice. Sixth, a strong branding and communication strategy can help to attract talent and user adoption.

Seventh, concessions and obligations are an excellent tool to tackle challenges concerning the high volatility in the market and multi-modal liabilities. Eighth, anchoring MaaS and getting the political buy-in helps to reach the critical MaaS and secure sustained funding. Ninth, the integration into societal goals links the concept closer to the cities and thus helps to formulate consistent regulation.

A fifth managerial implication is the cross-case analysis of the prospects for MaaS platforms (*see* Appendix J). Here, nine prospects emerged from the interview data, which can be seen as attributes of a future MaaS solution. First, intelligent and automated mobility settlement describes using barrier-free tokens to consume mobility in an automated way. Business to Business (B2B) – mobility budgets presents the participants' experiences focusing on the future concept of mobility budgets in the B2B space. Modularity and inclusion of other aspects emphasise the need for a modular MaaS platform to support a broader ecosystem in the future. Then, technical improvements and having a true meta app for mobility show the needed technical improvements in the future to make the vision of an actual meta app for mobility a reality. Besides these technological perspectives, two social prospects were discussed. The prospect of fairness and inclusion emphasised the importance of creating a fair and inclusive MaaS platform by providing a level playing field for all actors involved. Next, the prospect market saturation and mindset change demonstrated the market's future development and outlined essential aspects, including saturation and a needed mindset change. Finally, three policy and regulation prospects have been discussed. The prospect control instrument and tool for city planning introduced the concept of MaaS in the context of urban planning and controlling the development of cities.

With MaaS roaming, the experiences of the MaaS providers were analysed to create offerings that can plug into each other to create a seamless experience for the users. Finally, the prospect questions of ownership and being a certified MaaS provider approached the question of future ownership of MaaS platforms by highlighting the different perspectives of the participants. All these prospects provide deep insights for decision-makers in the field and help to accelerate the development of MaaS platforms.

7.4 Limitations and Directions for Future Research

Overall, the blossoming of MaaS platforms and the emergence of new platforms are increasingly essential for future mobility. Looking at the future, the concept of MaaS can support cities and citizens to develop and transform into sustainable mobility systems. This thesis laid the foundation for more case-specific analysis to help academics and practitioners build effective policies to let MaaS thrive.

Currently, many MaaS implementations are happening in Europe, and this study investigated cases focusing on urban MaaS. Future studies may seek to (1) research and compare the findings with other MaaS implementations, (2) uncover barriers in the context of rural MaaS implementations, or (3) generate best practice frameworks to overcome these barriers. Each potential avenue is discussed in more detail by comparing the planned quality criteria with the achieved quality criteria (*see* Section 4.4.5) using Guba and Lincoln (1994) and Yin (2018).

Concerning credibility and transferability, this study adopted ANT in combination with DSR. The resulting conceptual framework ensured that valid findings were gained. All the collected data show the experiences of the MaaS providers and their platforms in Europe.

This has also been beneficial to this thesis, as mobility differs globally. For example, a MaaS platform in a Chinese city might look different from an Indian or European city. Future studies could expand the sample size and compare and contrast the findings with other MaaS implementations worldwide. Still, the research design of this thesis ensured that the findings are valid and that there is high confidence that the findings can be generalised. The conceptualisation of this thesis can be used as a basis for such an investigation.

Besides that, dependability and confirmability were achieved by providing a chain of evidence and employing systematic data analysis procedures, ensuring that the findings are objective and neutral. This thesis focused on urban MaaS implementation operated in public-private partnerships. In these partnerships, the MaaS provider is in a public-private relationship with all other actors. Interpreting current MaaS implementations with this lens enabled the generation of comparable findings. Future studies may seek to expand the data corpus and validate the findings in other contexts. For example, the scope can be expanded by investigating rural MaaS implementations. In addition, the theoretical lens can be changed. This thesis investigated MaaS through the lens of ANT in combination with DSR and case study research. This lens helped to account for technical and non-technical actors similarly. With this, the thesis's findings enable the development of best practice frameworks to overcome MaaS barriers. Future research can either develop such frameworks using this theoretical approach or amend it using other theories.

Ultimately, this thesis serves researchers and practitioners as a knowledge source for further investigating the concept. By tackling MaaS barriers with new technology and policies, it is evident that the MaaS business ecosystem will continue to grow and mature over the next few years.

All codes and insights of this thesis can be expanded and further researched. One example is MaaS roaming, which will become increasingly important in the future.

In addition, the scope and development of MaaS are in constant flux. Just recently, Hensher and Hietanen (2022) introduced a paper discussing the future scope of MaaS, potentially renaming it in Mobility as a Feature (MaaF). This demonstrates that one of the prospects that emerged from this thesis, modularity of the platform and inclusion of other aspects, is already being discussed in the research. What is sure is that MaaS will play an essential role in our lives in the future, enabling and digitalising how we consume mobility in the future.

7.5 Reflective Commentary

My research path started as a tourist in another city wanting to consume mobility and starring at a vending machine selling train tickets. I looked at this vending machine with hundreds of buttons, uncountable tariff options, mechanic slots for payment and an unreadable display in the bright daylight. I thought to myself: In our digitised world, there must be another, easier way to consume mobility. So, I picked up my smartphone and searched for concepts for future mobility. What I found is that MaaS is the concept I needed at that point in time. However, I also discovered that MaaS is not a reality so far and is only being explored by some cities piloting it. This fact raised my curiosity, asking myself: Why is it not already there if we can stream music and movies or buy all kinds of things on the internet with just one click? It was clear that I wanted to contribute to making MaaS a reality in some way. Ultimately, this curiosity led me to the journey of this doctoral research. I have learned now that this vending machine can be considered the very antithesis of MaaS.

My doctoral research journey started with the taught stage of the Doctorate in Business Administration program DB8001-8004. During this stage, my fuzzy idea developed into something more tangible, an ontology that can be approached with epistemology. In addition, I learned how to conceptualise MaaS from different angles and reflected on my perception of how I define things and gather knowledge. Coming from a logical positivist stance, I realised that such an approach would be unsuitable for analysing the barriers in the MaaS business ecosystem.

Researching MaaS from the philosophical position of an interpretivist enabled me to investigate the barriers experienced by the MaaS providers profoundly. However, coming to this conclusion required a deep reflection process, but it helped me to grow my skills as a researcher by deeply identifying my assumptions and values. The most effective tool to sharpen my research throughout the process has been daily reflection, my research journal, and regular interlocks with my supervisors. These regular exchanges significantly helped me stay on track and tackle all unexpected situations and problems. I learned that reflexivity involves critical thinking about interpreting my very own role in research, including my values and assumptions. For the reflective narrative, I have used Kolb's experiential learning cycle throughout my research (*see* Figure 30), which provides a clear structure with defined phases and outputs.

Each cycle includes an evidenced narration based on a critical assessment of my personal experience, skills, values, and behaviours concerning my research topic and professional practice.

Most importantly, I learned that doctoral research never finishes and is a continuous process. It can be compared to a marathon and requires being open and flexible but critical in all situations. One of the most challenging situations has been to get to the conceptual model of this thesis. It required a deep understanding of the MaaS research domain and expert knowledge. The tool that helped me the most here has been the SLR which gives researchers a comprehensive method to get deep insight into any field.

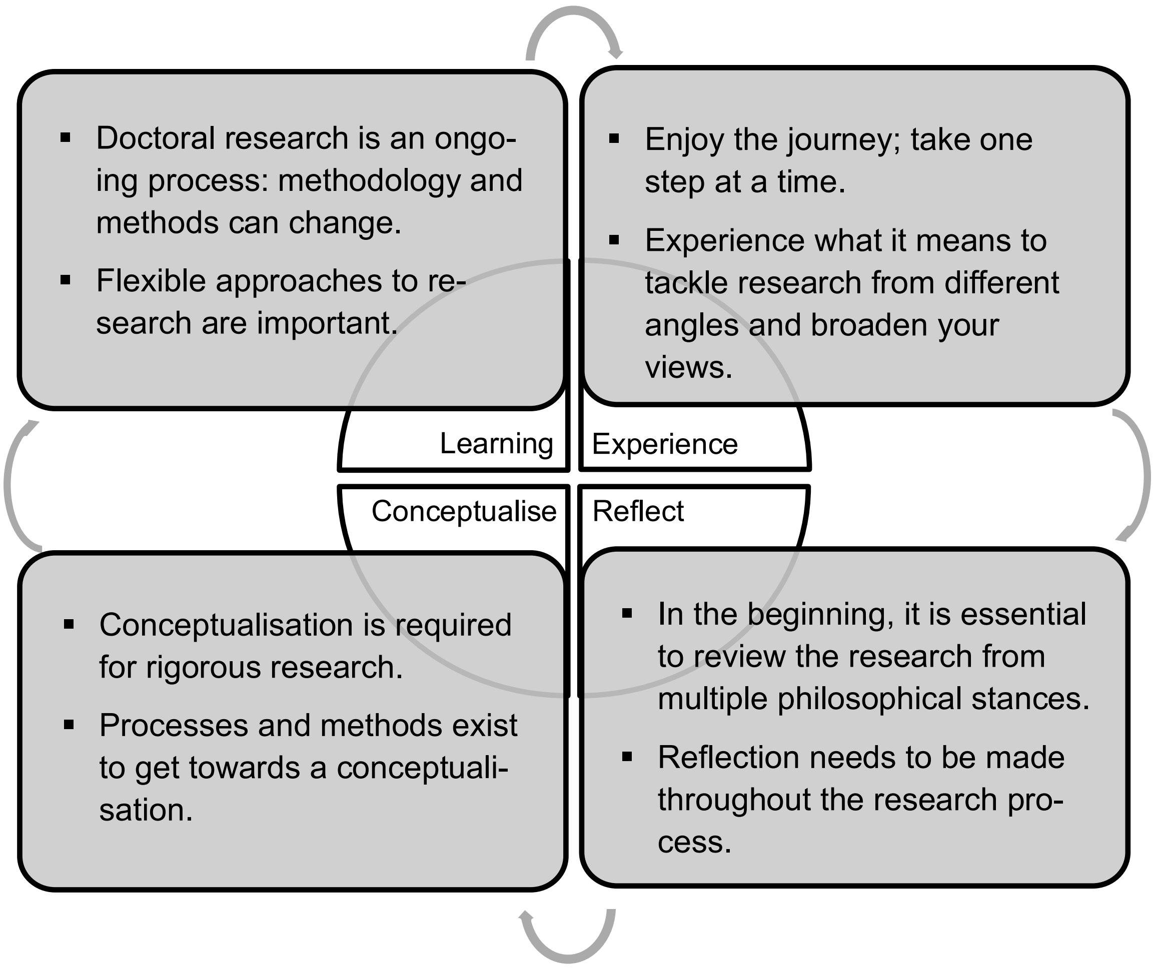


Figure 30. Experiential Learning Cycle adapted from Kolb (1984)

Also, what has been challenging was the data collection phase and getting access to the right participants for this study. I found that a successful strategy was to outline the participants systematically and create an appealing introduction letter to arouse their interest in participating in the study.

Embarking a doctoral journey besides a full-time job has been very challenging. I quickly realised that excellent time management, a clear focus and several sacrifices in my private life had to be made. Nevertheless, the journey was worth it, and through this journey, I was able to make an impact as a researcher in the field of MaaS.

Let me come back to this vending machine for transportation tickets. I am confident these vending machines will become a relic of the past, comparable to telephone boxes, which are rare in the modern world. If we manage to realise MaaS, it will significantly impact our future society. This research has advanced us one step closer to realising MaaS by understanding and addressing the barriers along the way.

Glossary

Term	*Definition*
Actor Network Theory	Actor Network Theory was developed in the 1980s by Bruno Latour, Michel Callon and John Law to study phenomena in which human and non-human actors are in a relationship and form a network. This thesis is used as a theoretical lens to examine how the MaaS business ecosystem is constructed and maintained.
Actor	Actors can be anything natural, technical, or human, such as a group of people, software, or material. In this thesis, actors are individual units related to the MaaS provider in the MaaS business ecosystem.
Actor Networks and Assemblages	An assemblage of actors is called an Actor Network. This actor network is formed through translation and consists of actors with links and relationships to the focal actor. In this thesis, actor networks have been used to formulate and conceptualise the MaaS business ecosystem.
Alliances	Alliances emerge if an actor is successfully enrolled on the network. In the actor network, groups of actors are forming alliances. In this thesis, alliances are represented through black boxes.
Artefact	The term artefact refers in this thesis to the individual actor networks which form through translating the cases. The use of the term underscores human and non-human actors, which form a complex network of relationships together: the MaaS business ecosystem.
Black Boxes	Black Boxes are well-established networks of allied actors so strong that they are only recognised as one actor. In this thesis, black boxes are used as a concept to abstract groups of actors in the MaaS business ecosystem.

Co-Creation	Co-Creation is a collaborative process in which all stakeholders work with diverse perspectives to achieve a specific solution. This concept emerged from the findings in this thesis and means that all actors work collaboratively to develop a MaaS platform.
Design Science Research	Design Science Research is a research methodology that focuses on developing artefacts by designing solutions for problems in the field. This thesis adopted it as methodology together with case study research to develop the MaaS business ecosystem actor network artefact.
Durability	Durability is considered the strength of alliances formed between the actors in the network. In this thesis, durability is represented through colour coding the relationships between actors in the individual actor networks.
Enrolment	Enrolment is the third moment when the other actors accept the focal actor and the role within the new network. Successful enrolment forms a network of alliances, and inscription happens. In this thesis, enrolment happens between actors in the MaaS business ecosystem.
Episode-Encounter Framework and Freeze Frames	The encounter-episode framework describes a process or network resulting from different encounters and episodes (Newman & Robey, 1992). This thesis adopts this view by using encounters as events that challenge the existing formation of actors in the network and episodes occurring between encounters. Each encounter represents a snapshot or freeze frame of the network. For example, the first encounter of the MaaS business ecosystem was after the SLR, while other encounters happened within the case analysis.

Ex-Ante and Ex-Post Evaluation	Sonnenberg and vom Brocke (2012) emphasise that evaluation happens after each Design Science Research phase, which can be either before (ex-ante) or after (ex-post) the construction of the artefact. In this thesis, these evaluation activities were adopted and happened throughout the process of creating the MaaS business ecosystem.
Inscription	The inscription is the process of creating technical artefacts which enforce the power and position of an actor's interests in the network (Sarker et al., 2006). Inscription and translation are iterative, constantly flowing as the network changes. In this thesis, inscription happens after each MaaS business ecosystem actor network encounter.
Interessement	Interessement is considered the second translation moment when the focal actor convinces other actors to accept his position in the network (Callon, 1986). In this thesis, the interessement describes the value proposition for each actor to join the MaaS business ecosystem actor network.
Level Playing Field	A Level Playing Field is a concept that refers to a fair and equitable competition where all participants have an equal opportunity to succeed. In the context of this thesis, a level playing field means that a MaaS platform does not have any entry barriers for new players to join the MaaS business ecosystem.
MaaS Business Ecosystem	The MaaS Business Ecosystem is the most central concept in this thesis and involves all actors with a relationship with the MaaS provider. This thesis adopted the conceptual understanding of Kamargianni and Matyas (2017) and reshaped it with Actor Network Theory.
MaaS Champions	The MaaS Champion provides strong leadership amongst the actors participating in the MaaS business ecosystem. The MaaS champion manages and resolves tensions among the actors by providing clear leadership and focuses during the MaaS business ecosystem enrolment process (Guyader et al., 2021).

MaaS Platform	The MaaS Platform is the product which the MaaS provider offers. It offers all mobility services of the actors in the MaaS business ecosystem to the user.
MaaS Provider or Focal Actor	The MaaS Provider is the focal actor of the MaaS business ecosystem. Being at the heart of the MaaS business ecosystem, the MaaS provider manages the multi-actor environment and integrates and offers the best mode of travel in terms of time-saving, cost-saving, or customised settings into the MaaS platform (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020 ; Xing et al., 2019).
MaaS User	The MaaS User is consuming the mobility services the business ecosystem provides by booking the services or having subscription plans (Mulley & Nelson, 2020). The users can be private users like residents, visitors, tourists, or corporate customers (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020).
Mobilisation	Mobilisation of allies is the fourth and last moment of translation. Mobilisation is when the actors or alliances in the network establish representatives to avoid betrayal in the actor network (Callon, 1984). In this thesis, mobilisation happens when the actor network of the MaaS business ecosystem is evolving and MaaS champions are emerging.
Obligatory Passage Points	An Obligatory Passage Point between the other actors and the networks means that the focal actor becomes indispensable to them (Callon, 1986). In this thesis, each actor in the MaaS business ecosystem establishes obligatory passage points to the MaaS provider.
Public Private Partnerships	Public Private Partnerships are collaborations between public and private parties in which they jointly finance, develop and operate the MaaS platform. This reduces the costs and complexity of each of the involved actors.

Problematisation	Problematisation is the first moment of translation and relates to the process of formulating the problem or network that needs to be researched. In this thesis, problematisation happens when the MaaS provider offers the platform as obligatory passage points to other actors in the MaaS business ecosystem.
Public and Private Mobility Service Provider	Mobility Service Providers offer mobility services and provide the MaaS provider access to their data using APIs (Kamargianni & Matyas, 2017). Public mobility service providers offer all public transport-related services to the MaaS provider. Private mobility service providers offer individual services like taxis, carpooling, e-scooter and city bikes, flights, freight delivery and many more (Mulley & Nelson, 2020).
Translation	Translation within the network is achieved through common definitions, meanings and inscriptions attached to the technology (Lorna & Janet, 2011). In this thesis, the four moments of translation of Callon (1984) are used as a central concept to understanding the MaaS business ecosystem actor networks: Problematisation, Interessement, Enrolment and Mobilisation.

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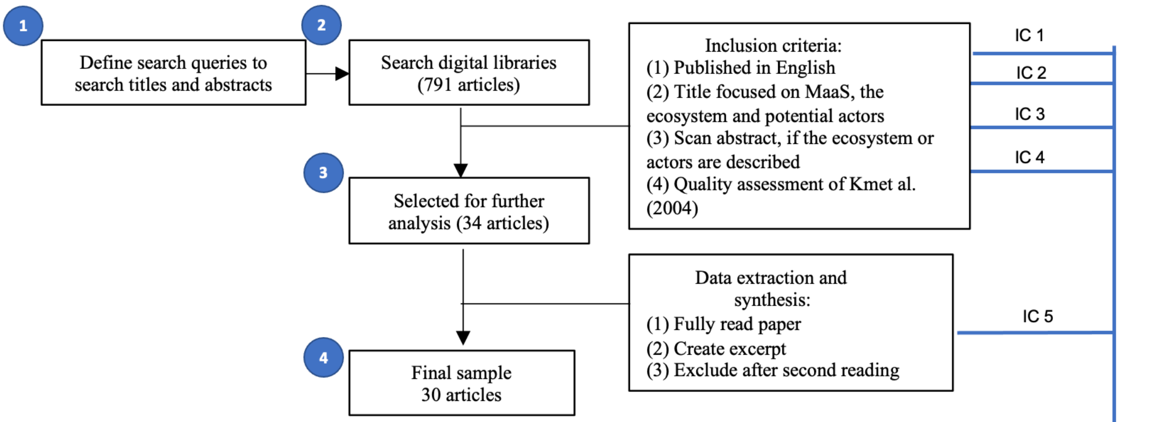
List of Appendices

Appendix A: Literature Search and Four Step Selection Procedure

The entire literature search, study selection and quality assessment procedure can be found in the Excel, which has been attached to this thesis. Figure 31 depicts the four-step selection procedure used as part of the SLR. The five inclusion criteria are listed in the top right, the middle introduces the search terms, and the bottom is the sampling procedure.

Systematic Literature Search and Selection Process: MaaS Business Ecosystem Actors and Barriers



Search terms and digital libraries (date of research: 01/30/2023)

Digital Library	Search Query	No. of results
Google Scholar:	"Mobility as a Service" AND ("actor" "barrier" OR "business ecosystem" OR "ecosystem" OR "network")	438
IEEE Xplore:	(("Document Title":Mobility as a Service) AND (("Abstract":"actor") OR ("Abstract":"barrier") OR ("Abstract":"business ecosystem") OR ("Abstract":"ecosystem") OR ("Abstract":"network")))	193
Scopus	"Mobility as a Service" AND ("actor" OR "barrier" OR "business ecosystem" OR "ecosystem" OR "network")	69
EBSCO	"Mobility as a Service" AND AB ("actor" OR "barrier" OR "business ecosystem" OR "ecosystem" OR "network")	58
Web of Science:	TI="Mobility as a Service" AND AB=("actor" OR "barrier" OR "business ecosystem" OR "ecosystem" OR "network")	33
Total		**791**

Filtering based on inclusion criteria and data extraction and synthesis

Total mumber of articles found in digital libraries	791	
Total number of articles after cleaning of duplicate results	652	
IC1: Published in English	632	IC 1
IC2: Title focused on MaaS, the ecosystem and potential actors and barriers	296	IC 2
IC3: Scan abstract, if the ecosystem or actors are described	72	IC 3
IC4: Quality Assessment of Kmet et al. (2004), Cut-Off Score: 0.80	34	IC 4
Final Sample	30	IC 5

Figure 31. Systematic Literature Search and Selection Procedure

Appendix B: Quality Scoring of Qualitative Studies and Results

Table 56 describes the quality criteria and their scale of Kmet et al. (2004), which is used for assessing the research papers of the SLR.

Table 56. Scoring Schema as introduced by Kmet et al. (2004)

Criteria		Yes (2)	Partial (1)	No (0)
1	Question / objective sufficiently described?	Research question or objective is clear by the end of the research process (if not at the outset).	Research question or objective is vaguely/incompletely reported.	Question or objective is not reported or is incomprehensible.
2	Study design evident and appropriate?	Design is easily identified and is appropriate to address the study question.	Design is not clearly identified, but gross inappropriateness is not evident, or design is easily identified, but a different method would have been more appropriate.	The design used is not appropriate to the study question (e.g., a causal hypothesis is tested using qualitative methods), or the design cannot be identified.
3	Context for the study clear?	The context/setting is adequately described, permitting the reader to relate the findings to other settings.	The context/setting is partially described.	The context/setting is not described.
4	Connection to a theoretical framework / wider body of knowledge?	The theoretical framework/wider body of knowledge informing the study and the methods used is sufficiently described and justified.	The theoretical framework/wider body of knowledge is not well described or justified; the link to the study methods is not clear.	The theoretical framework/wider body of knowledge is not discussed.
5	Sampling strategy described, relevant and justified?	The sampling strategy is clearly described and justified. The sample includes the full range of relevant, possible cases/settings (i.e., more than simple convenience sampling), permitting conceptual (rather than statistical) generalizations.	The sampling strategy is not completely described or is not fully justified. Or the sample does not include the full range of relevant, possible cases/settings (i.e., includes a convenience sample only).	The sampling strategy is not described.
6	Data collection methods clearly described and systematic?	The data collection procedures are systematic and clearly described, permitting an “audit trail” such that the procedures could be replicated.	Data collection procedures are not clearly described; difficult to determine if they are systematic or replicable.	Data collection procedures are not described.
7	Data analysis clearly described and systematic?	Systematic analytic methods are clearly described, permitting an “audit trail” such that the procedures could be replicated. The iteration between the data and the explanations for the data (i.e., the theory) is clear – it is apparent how early, simple classifications evolved into more sophisticated coding structures which then evolved into clearly defined concepts/explanations for the data). Sufficient data is provided to allow the reader to judge whether the interpretation offered is adequately supported by the data.	Analytic methods are not fully described. Or the iterative link between data and theory is not clear.	The analytic methods are not described. Or it is not apparent that a link to theory informs the analysis.
8	Use of verification procedure(s) to establish credibility?	One or more verification procedures were used to help establish the credibility/trustworthiness of the study (e.g., prolonged engagement in the field, triangulation, peer review or debriefing, negative case analysis, member checks, external audits/inter-rater reliability, “batch” analysis).	Not described.	Verification procedure(s) not evident.
9	Conclusions supported by the results?	Sufficient original evidence supports the conclusions. A link to theory informs any claims of generalisability.	The conclusions are only partly supported by the data. Or claims of generalisability are not supported.	The conclusions are not supported by the data. Or conclusions are absent.
10	Reflexivity of the account?	The researcher explicitly assessed the likely impact of their own personal characteristics (such as age, sex, and professional status) and the methods used on the data obtained.	Possible sources of influence on the data obtained were mentioned, but the likely impact of the influence or influences was not discussed.	There is no evidence of reflexivity in the study report.

Table 57 shows the scoring results of research papers using a cut-off score of > 0.8.

Table 57. Assessed Research Papers with Quality Criteria of Kmet et al. (2004)

Quality Criteria / Research Paper	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Total Score
Mobility as a Service (MaaS) Ecosystems and Architectures—An Overview of, and a Definition, Ecosystem and System Architecture for Electric Mobility as a Service	2	1	2	2	2	2	2	1	1	2	0.85
A Literature Review on Interactions Between Stakeholders Through Accessibility Indicators Under Mobility as a Service Context	2	2	2	1	2	2	2	1	2	2	0.9
Future implementation of mobility as a service (MaaS): Results of an international Delphi study	2	2	2	2	2	2	2	2	1	1	0.9
How Mobility as a Service Impacts Public Transport Business Models	2	2	2	2	2	2	2	2	1	1	0.9
Institutional Logics at Play in a Mobility-as-a-Service Ecosystem	2	2	2	2	2	2	2	2	2	1	0.95
Interplay of Policy Experimentation and Institutional Change in Transformative Policy Mixes: The Case of Mobility as a Service in Finland	2	2	2	2	2	1	1	1	2	2	0.85
Interpretative flexibility and actor conflicts in the emergence of Mobility as a Service: A perspective from Finland	2	2	2	2	2	2	2	2	1	1	0.9
Investigating individual preferences for new mobility services: the case of “mobility as a service” products	2	2	2	2	2	2	2	2	2	1	0.95
Linked MaaS: a vision for leveraging Semantic Web Technologies for Mobility as a Service	2	2	2	2	2	2	2	1	1	1	0.85
Mobility as a Service (MaaS): a digital roadmap for public transport authorities	2	2	2	2	2	1	2	1	2	1	0.85
Mobility as a Service business and operator models	2	2	2	1	2	1	2	2	1	2	0.85
Mobility as a Service for public-private partnership networks in the rural context	2	2	2	2	2	2	2	2	1	1	0.9
Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges	2	1	2	2	2	1	2	1	2	2	0.85
Mobility as a Service: Stakeholders and Challenges	2	2	2	2	2	2	1	1	2	1	0.85
Mobility as a Service: What is it and which problems could it solve	2	2	2	2	2	2	1	2	1	1	0.85
Mobility-as-a-Service (MaaS) Business Model and Its Role in a Smart City	2	2	2	2	2	1	2	1	2	1	0.85
Mobility-as-a-Service: a critical review and the generalized multi-modal transport experience	2	2	2	2	2	1	2	2	1	2	0.9
Mobility-as-a-Service: a tentative framework for analysing institutional conditions	2	2	2	2	2	2	2	1	1	2	0.9
Mobility-As-A-Service: Concepts and Theoretical Approach	2	2	2	2	2	2	1	1	2	2	0.9
Mobility-as-a-service: insights to policymakers and prospective MaaS operators	2	2	2	2	1	2	2	2	1	1	0.85
Mobility-as-a-service: Tentative on users, use and effects	2	2	2	1	2	2	1	1	2	2	0.85
Mode-agnostic mobility contracts: identifying broker/aggregator models for delivering mobility as a service (MaaS)	2	2	2	2	2	2	1	1	2	1	0.85
Organizing integrated services in mobility-as-a-service systems: Principles of alliance formation applied to a MaaS-pilot in the Netherlands	2	2	2	2	2	2	2	1	2	1	0.9
Perceived action spaces for public actors in the development of Mobility as a Service	2	2	1	2	2	2	1	2	1	2	0.85
Prospects for Mobility as a Service	2	2	2	2	1	2	1	2	1	2	0.85
Prototype business models for Mobility-as-a-Service	2	2	2	2	1	2	2	1	2	2	0.9
Public–private innovation: barriers in the case of mobility as a service in West Sweden	2	2	1	2	2	1	2	2	1	2	0.85
Questioning Mobility as a Service: Unanticipated societal and governance implications	2	2	2	1	2	2	1	2	1	2	0.85
Ready for Mobility as a Service? Insights from stakeholders and end-users	2	2	2	2	2	1	1	2	1	2	0.85
Stated preference design for mobility as a service (MaaS) broker/aggregator contracts	2	2	2	2	1	1	2	2	1	2	0.85
The business ecosystem of mobility-as-a-service	2	2	2	2	2	2	2	1	2	1	0.9
The mobility as a service maturity index: Preparing the cities for the mobility as a service era	2	2	2	1	2	2	1	1	2	2	0.85
The Ws of MaaS: understanding mobility as a service from a literature review	2	2	2	2	2	2	1	2	1	2	0.9
Towards a framework for Mobility-as-a-Service policies	2	2	2	2	1	2	1	2	1	2	0.85
Total (IC4)											**34**
Total (IC5) Data Extraction and Synthesis											**30**

Appendix C: Letter of Introduction

School of Business and Technology
Oxstalls Campus
Gloucester GL2 9HW
United Kingdom

M.Sc. Julian Gebhart
Tel: 00 49 1577 681 1026
julian.gebhart@de.ibm.com

Letter of Introduction

My name is Julian Gebhart, and I work as a Managing Consultant and Solutions Architect at IBM and am pursuing a part-time Doctorate in Business Administration (DBA) at the University of Gloucestershire. As part of my studies, I am completing a study on the topic below and would like to explore the Mobility as a Service (MaaS) business ecosystem in more detail in practice.

Title: Evaluating Barriers in the Business Ecosystem of European MaaS Providers: An Actor Network Approach

My research aims to understand better the barriers faced by key players in the MaaS business ecosystem in order to develop effective strategies and guidelines for MaaS platforms in Europe. To this end, I have systematically analysed over 100 academic papers and publications to characterise and outline the MaaS business ecosystem. This analysis resulted in a preliminary MaaS business ecosystem artefact under-pinned by Actor Network Theory (ANT) as a theoretical foundation. As part of my empirical research, I would like to conduct a case study on your MaaS offering. For this, I am looking for participants who have management experience, are involved in strategic decisions, and can share their experiences with barriers in the MaaS business ecosystem.

I would like to present my research artefact and complement it with the perspectives and experiences of your experts. For this purpose, I would like to conduct individual interviews with your company's participants and other experts. These individual interviews would take about 1 hour.

The interview will be audio-recorded and held in German or English. The interview will take place virtually or on-site. After the interview, the audio will be transcribed and translated into English for further analysis. The transcript will be anonymised and shared for approval with the interviewee(s) before it is used for further research.

The following protocol questions will be asked in the interview:

1. Please introduce yourself. What is your profession?
2. How would you define MaaS and its business ecosystem in your own words?
3. How do you identify or analyse the relationships between the different actors within your MaaS business ecosystem?
4. After seeing this artefact. Walk me through it and describe the relationship between your company and other actors in the MaaS Business Ecosystem. How would you characterise your relationship with them and see potential barriers?
5. How do you get in contact with new actors and get them interested in your solution?
6. Once onboarding is decided, how do you integrate or enrol new actors in your network?
7. Think of a critical situation where you experienced a barrier with an actor in the MaaS business ecosystem. Which strategy did you adopt to overcome the barrier?
8. Which external measures would support the development of your platform?
9. Imagine a future city or world with a perfect MaaS solution. What does this ecosystem look like? Let us walk through your vision and compare it with the actor network from literature.

It is important to mention that the University of Gloucestershire Research Ethics Committee has approved this research project. Please be assured that any information provided will be treated in the strictest confidence. None of the participants will be individually identifiable or harmed in the resulting thesis, report, or other publications.

The research findings of this work will be published after the completion of the study. In addition, I will provide you with an individual research report, free of charge, containing all the research findings and artefacts of this study.

If you are willing to participate in this case study or help with recruitment, please reply to this email, or forward this request to all eligible participants in your company.

Thank you for your support and assistance.

Yours sincerely,
Julian

Appendix D: Informed Consent Form

Informed Consent Form

Name of DBA Candidate and Interviewer: Julian Gebhart

Name of Participant:

You are invited to participate in case study research to identify barriers in the MaaS business ecosystem to develop effective strategies and policies. The research and its procedure have been introduced in the letter of introduction. I consent to voluntarily participate in this case study research by signing this form. I have read and understood, and agree to the following:

#	Informed Consent Principles of this Research
1	I understand the information provided in the letter of introduction.
2	I understand that I am participating in a DBA research case study.
3	I understand that personal information will not be published.
4	I understand that confidentially and anonymity will always be ensured.
5	I understand that I will be audio-recorded during the interview.
6	I understand that the audio-recording will be used to generate a transcript using automatic transcription software and will be translated to English if needed.
7	I understand that the transcript will be anonymised and shared for approval before it is used in this study.
8	I understand that parts of the approved anonymised transcript will be published.

I would like to receive a copy of the research results of this study: ☐ YES ☐ NO

Date:

Signature:

Appendix E: Pilot and Main Case Study Interview Protocol

Table 58 introduces the pilot interview questions, which were asked to get the requirements of the participants of the first empirical research stage.

Table 58. Pilot Interview Guide

#	Pilot Research Questions
1	Please introduce yourself. What is your profession?
2	Please describe your company and what it offers. How would you define MaaS and characterise your MaaS business ecosystem?
3	To what extent are you mapping actors or creating a map of actors which are part of your offering? If not, what would be your requirements to do so?
4	From your experience, what barriers with other actors of the MaaS business ecosystem are hindering you from growing your network solution faster? How would you map barriers in your network?
5	Which external regulations, policies or action plans would help you to scale up the development of your offering? What would be your requirements for such regulations, policies, and action plans?

For the main empirical research stage, the meeting structure has been improved based on the feedback from the pilot interviews. This updated structure can be found below in Table 59.

Before that, the following points reflect the style and agenda of these interviews:

1. Introduction round (interviewee + interviewer).
2. Purpose and goals of the research and ethical confirmations, confirm the timing with them and check the informed consent form to start the audio recording.
3. Interview Style: open, free talking, little guidance, deductive, but as well inductive parts.
4. Introduce to Interview Structure: Parts A, B, C.
5. Interview topics and questions covered.

Table 59. Mapping Main Research Questions to the Protocol Questions and Literature

Part A – Introduction and Context of Case Environment ***Research Question:*** What are the key elements and actors of the MaaS business ecosystem? ***Conceptual Mapping:*** Verification of case selection criteria, deductive actor identification and alignment of the conceptual understanding.
Main Question A1: Please introduce yourself. What is your profession? ➢ *Probes:* Can you explain this role? Can you name what your responsibilities are in this role? ➢ *Objective:* To introduce each other and to validate that the chosen person matches the expert selection criteria. ➢ *Expected Data:* Information about the person's professional background and experience in the MaaS field and case. ➢ *Analysis:* Anonymised evidence that can be used to describe how and why the particular person matches the selection criteria.
Main Question A2: How would you define MaaS and its business ecosystem in your own words? ➢ *Probes:* From your experience, what are the core characteristics / key components of MaaS? Which actors should be part of the MaaS business ecosystem? ➢ *Objective:* To learn more about interviewees' conceptual understanding of MaaS and its business ecosystem. ➢ *Expected Data:* A verbal definition of MaaS and its business ecosystem. ➢ *Analysis:* Cite evidence about the definition of MaaS and its business ecosystem and align it with this thesis's conceptual understanding and core characteristics.
Main Question A3: How do you identify or analyse the relationships between the different actors within your MaaS business ecosystem? ➢ *Probes:* How or to what extent are you analysing the relationships between the different stakeholders within your MaaS business ecosystem? To what extent are you mapping actors or creating a map of actors which are part of your solution? If not, what would be your requirements to do so? What are your criteria for identifying a potential candidate? ➢ *Objective:* To learn more about interviewees' requirements towards mapping and analysing relationships within the MaaS ecosystem. ➢ *Expected Data:* Insights into mapping and analysis processes in the MaaS business ecosystem. ➢ *Analysis:* Cite evidence about the usage of mapping and analytic processes in the MaaS business ecosystem.

<u>Part B – ANT Translation and Barriers in the MaaS Business Ecosystem</u>

<u>The Case-Specific MaaS Business Ecosystem Actor Network Artefact is presented.</u>

Research Question: How can the MaaS business ecosystem be assembled and translated (problematised, interested, enrolled, and mobilised) with ANT?

Conceptual Mapping: ANT translation: problematisation, interessement, enrolment, and mobilisation of barriers identified from the SLR.

<u>Main Question B1</u>: After seeing this artefact. Walk me through it and describe the relationship between your company and other actors in the MaaS Business Ecosystem. How would you characterise your relationship with them and see potential barriers?

- *Probes:* Which actors are missing? What should be changed? From your experience in the field, what hinders the development of MaaS the most? Which interplay of actors (relationships) is causing the most pain? Which actors are the source of one barrier, and which actor should address the issue to resolve it? What barrier has your company chose not to confront?
- *Objective:* To learn more about the application of the MaaS business ecosystem artefact in its practical context, about the relationships of the key actors and the obligatory passage point to the focal actor (case company) in the MaaS business actor network.
- *Expected Data: E*vidence on application and feedback concerning the artefact. Insights about relationships, their characteristics and barriers.
- *Analysis:* Cite evidence about findings from applying the artefact and feedback received from the interviewee.

<u>Main Question B2</u>: How do you get in contact with new actors and get them interested in your solution?

- *Probes:* How do you grow your network and business ecosystem? How are you deciding about the actors with which to grow? Which issues or barriers hindering you from growing your network? Name reasons why actors would not join your solution.
- *Objective:* To learn more about barriers the focal actor faces when growing their business ecosystem.
- Expected Data: Insights about new actors' decision and onboarding processes and the formation of alliances.
- *Analysis:* Cite evidence about findings and compare the relationships to the conclusions of the literature review.

Main Question B3: Once onboarding is decided, how do you integrate or enrol new actors in your network?

- *Probes:* What challenges or blocks the onboarding and (deep) integration in the network? What barrier has your company chosen not to face when integrating new actors?
- *Objective:* To learn more about barriers experienced during the onboarding and integration processes of actors in the MaaS business ecosystem of the case company.
- *Expected Data:* Insights about barriers in the onboarding and integration phase.
- *Analysis:* Cite evidence about the findings and compare the barriers to the findings from the literature review.

Part C – Learnings and Strategies to Overcome Barriers and Perspectives for the Future MaaS Business Ecosystem

Research Question: How can the MaaS actor network be used to evaluate case-specific barriers in MaaS business ecosystems?

Conceptual Mapping: Inductive exploration of learnings, strategies, and perspectives to overcome the MaaS business ecosystem barriers.

Main Question C1: Think of a critical situation where you experienced a barrier with an actor in the MaaS business ecosystem. Which strategy did you adopt to overcome the barrier?

- *Probes:* What are the main issues that need to be addressed to accelerate the emergence of MaaS? What additional strategies have you developed with the new players in the MaaS business ecosystem to overcome problems and barriers?
- *Objective:* To explore the case companies' strategies to overcome the barriers and issues in the MaaS business ecosystem.
- *Expected Data:* Learnings and strategies to overcome the barriers, deep insights into the decision-making of the case company.
- *Analysis:* Cite evidence about the strategies to overcome the barriers in the MaaS business ecosystem.

Main Question C2: Which external measures would support the development of your platform?

- *Probes:* What changes in user habits or regulations would be necessary to build a MaaS platform faster? Are you part of any (local, global) initiatives or alliances? What external measures (e.g. funding or legislation) would support your development? What needs to change in future to overcome the current existing barriers?
- *Objective:* To explore characteristics of potential regulations, policies or action plans that would help to speed up the development of MaaS and its ecosystem.

- *Expected Data:* Characteristics of regulations, policies or other measures.
- *Analysis:* Cite evidence about external regulations, policies or action plans that help to overcome the barriers.

The MaaS Business Ecosystem Actor Network from the Literature Artefact is presented.

Main Question C3: Imagine a future city or world with a perfect MaaS solution. What does this ecosystem look like? Let us walk through your vision and compare it with the actor network from literature.

- *Probes*: What are your expectations in this field for the future? Which actors will be most relevant in future? How might your current role in the MaaS business ecosystem change? How do you anticipate how the MaaS business ecosystem will change in future?
- *Objective:* To explore permutations happening currently in the MaaS business ecosystem and perspectives for the future MaaS business ecosystem.
- *Expected Data:* Permutations in the ecosystem, opinions and narratives on the future of the MaaS business ecosystem.
- *Analysis:* Cite evidence about opinions on the future of the MaaS business ecosystem and compare those findings with the current state of literature.

Appendix F: Expected Interview Answers and Scale for Analysis

Table 60 maps the previously introduced interview questions with expected answers and themes, the scales, the expected impact on artefact evaluation and the original concepts and sources from the literature.

Table 60. Expected Interview Answers (Themes) and Scale Development for Analysis

Expected Answers (Themes)	**Scale**	**Expected Impact on Artefact Evaluation**	**Concept and Source**
A1: *Please introduce yourself. What is your profession?*			
Open	Narrative	Rigour and matching case selection criteria for further evaluation.	Case selection criteria of Section 4.4.1.
A2: *How would you define MaaS and its business ecosystem in your own words?*			
Characteristics of MaaS	Integration of Transport Modes	Understanding of MaaS and its characteristics are aligned with the artefact.	Nine core characteristics of Jittrapirom et al. (2017).
	Tariff Option		
	One Platform		
	Multiple Actors		
	Usage of Technologies		
	Demand Orientation		
	Registration Requirement		
	Personalisation		
	Customisation		

	End-User Perspective		Four characteristics of Giesecke et al. (2016).
	Interoperability		
	Nature of Travel		
	Sustainability		
Conceptual understanding of the MaaS business ecosystem	Focal Actor	Conceptual understanding of MaaS is aligned with the artefact.	Conceptual understanding of Kamargianni and Matyas (2017).
	Core Business		
	Extended Enterprise		
	Wider Ecosystem		
<u>A3:</u> *How do you identify or analyse the relationships between the different actors within your MaaS business ecosystem?*			
Regulatory Organisations	Unions	Artefact can map existing actors of the MaaS business ecosystem in the case company.	Results of the SLR containing the insights of 30 authors/papers. ANT of Latour (1984) and translation.
	International Organisations		
	Government & Legislation		
	Local Authorities		
Transport Service Providers	Public Mobility Service Providers		
	Private Mobility Service Providers		
	Logistics Service Providers		
Digital Service Providers	Aggregators, Integrators and Brokers		

	Dynamic Multi-Service Journey Planners		
	Ticketing and Payment Solution Providers		
	Technology and IT Providers		
ICT Infrastructure	Telco Companies		
Customers and Users	Customers and Users		
Wider Ecosystem	Universities and Research Institutes		
	Investors and Funding Agencies		
	Media / Marketing and Entertain-ment Firms		
	Insurance Companies		
	OEMs and Resellers		
	MaaS Champions		
	Tariff Options		
	One Platform		
	Multiple Actors		
	Usage of Technologies		

	Demand Orientation		
	Registration Requirement		
	Personalisation		
	Customisation		
	Core Business		
	Extended Enterprise		
	Wider Ecosystem		
B1: *After seeing this artefact. Walk me through it and describe the relationship between your company and other actors in the MaaS Business Ecosystem. How would you characterise your relationship with them and see potential barriers?*			
Technology and Data	Data Security and Privacy	Artefact provides useful insights for barriers in the theme technology and data.	Authors are stated in Section 3.7.2 and 3.7.3. The structure is derived from Section 2.3.4.
	Lack of Openness of Metadata and Standardisation: Data Silos and Interoperability		
	Modernisation of ICT Infrastructure, Internet Coverage and Real-time Information available		
	Unclear / No Platform Architectures existing		

Social and Cultural	Acceptance of Users, Travel Behaviour, Lack of User Trust	Artefact provides useful insights for barriers in the theme social and cultural.	
	Competition, Losing Monopoly Position, Control, and Influence		
	Missing Collaboration		
	Missing Leadership and Vision		
	Skills and Knowledge Gaps		
Policy and Regulation	Demand Estimation, Creation of Business Models, Tailoring of Services	Artefact provides useful insights for barriers in the theme policy and regulation.	
	Legal Issues, Bureaucracy, and Institutional Barriers		
	Poor Governance Frameworks, Policy, and Regulation Challenges		
B2: *How do you get in contact with new actors and get them interested in your solution?* **B3:** *Once onboarding is decided, how do you integrate or enrol new actors in your network?*			

Insights into the translation processes of the case company	Problematisation Interessement Enrolment Mobilisation	Artefact can be used for translating relationships in the case company.	Latour (1984) four moments of translation.
C1: *Think of a critical situation where you experienced a barrier with an actor in the MaaS business ecosystem. Which strategy did you adopt to overcome the barrier?*			
Elaboration on a critical incident	Perspectives on Strategies to Overcome the Barriers	Inductive development for strategies that complement the artefact.	Keaveney (1995)
C2: *Which external measures would support the development of your platform?*			
Open	*Regulations* *Policies* *Action Plans*	External validation and inductive development of strategies, policies and action plans based on artefact.	Regulation, policies and action plans to overcome the barriers Smith et al. (2019), Polydoropoulou, Pagoni and Tsirimpa (2020), Butler et al. (2021).
C3: *Imagine a future city or world with a perfect MaaS solution. What does this ecosystem look like? Let us walk through your vision and compare it with the actor network from literature.*			
Open	Narrative	Future development and perspectives of MaaS.	-

Appendix G: Pilot Interview Findings

This appendix introduces the pilot procedure adopted for gathering participant data. Then, the pilot interview findings are presented, analysing evidence from the empirical findings from the interviews. After that, the resulting preparations for the main case studies are derived.

In order to gather valuable insights and perspectives on the topic under investigation, individual experts in the field were shown the questions beforehand. The first interview (PI1) was conducted with a topic expert, while the second interview (PI2) was conducted with a researcher who is also an IEEE senior member. Before each interview, the questions were introduced during a 30-minute introductory meeting. During this meeting, the interviewee was first introduced to the topic and then placed in the interview situation, answering the questions from their area of expertise, and commenting on the specific questions being asked.

PI1 was conducted with a digitalisation expert for building MaaS solutions. First, the expert was introduced to the research topic. The feedback was that the design and objective of this research are quite clear and that he sees value in it. The main questions were about the time constraints set for the SLR: “is it relevant to still look into the articles of 2014? Maybe the most interesting are starting like in 2019 or something like that” (PI1). Here, the strategy of looking at the godfather paper and forward and backward search was explained. The use of actor network theory to represent MaaS business ecosystems was well received. Another question asked by PI1 “Do you also have a time point of view, like, actors who could be included at some point. And if not, why not?” (PI1). Here the encounter episode framework was explained, and how the actors were systematically collected from the literature. After that, PI1 described the approach as, “yeah, absolutely, it is very clear” (PI1).

The methodology was then explained. Here it was made clear that I contextualised design science with case study research. The next step was to familiarise PI1 with the interview guide and questions. Then PI1 was put in an interview position while PI1 commented on the questions with his expert knowledge and indicated whether the questions were relevant from his point of view. Starting with the first question, A1, PI1 introduced himself and explained his role and experience with automotive. Then with A2, PI1 defined MaaS from two perspectives “the first perspective is from the client perspective, the customer. What it brings to him is to centralise all the services, so that’s his experience and journey is simplified so that he can enjoy all the capabilities he has for mobility and security, by having one single point of contact who he can trust and understand the evolution. And from a business perspective, it’s the way to unify and simplify all the relationships and contents. So, that most of the data can be shared in a normal understandable way, and “that the actors can build together new business outcomes within the network but also with other networks” (PI1). The next question had been A3. Here, the feedback from PI1 was that he expects that the companies “really rare to have a centralised view” (PI1). For this reason, it would sense to identify who is “using such kind of a matrix kind of analytics and then choose a standard so that you can have a common vocabulary and patterns” (PI1). That is why PI1 thinks that this question is important and that it is “indeed one of the first points. Like, what is the maturity of the topic? Do they already track it, and if they wanted to check it better, what would be the tools to do so” (PI1).

After that, B1 was introduced. It was agreed that potential barriers could exist between the different actors of the ecosystem. Here PI1 brought up that “they also have some obstacles or possible view within the company within the, MaaS provider company” (PI1).

While the internal view of the MaaS company is an interesting perspective, this study focuses more on understanding how MaaS providers interact with other actors from the MaaS business ecosystem. Another addition to PI1: It would be helpful to compare urban MaaS implementation with global applications, at least when considering them as data providers. The consensus is that scaling up later with global applications and platforms would be useful. Still, this research needs to start with the current state, where individual solutions are developed for cities. PI1 suggested that it would make sense for future research to “understand the relationship between one provider and another one” (PI1). This is a good topic for further research to develop integration between different MaaS platforms. In addition, PI1 proposed to understand why policies or, in general, the implementation of MaaS work better in some countries than others. This is what this research aims to achieve, and in the future, this research can be conducted at an international level to understand what barriers exist globally. For B2, PI1 suggested first learning more about the solution and then understanding its widespread. Here it is obvious that the researcher is already aware of his network and is more interested in how to get new actors interested in the topic. Regarding the B2 question concerning the integration process of new actors, the feedback that PI1 thinks that “all the actors who are joining the network should define a ROI” (PI1). This continues as well to the critical situation question C1. PI1 expects “there would be a strategy, like a conscious one” (PI1). Further, PI1 suggested also asking if they see any market development that helped them develop a strategy. This was already addressed in C2, where external measures were asked about. Here PI1 suggested asking the respondents also about their points of view on external technology.

Before the interview, there were two questions, C3 and C4. These questions were combined based on the feedback from PI1. In summary, PI1 provided valuable points and suggested how the vision could be amended by involving energy companies and focusing on the expected outcome and the monetisation model.

PI2 was conducted with an experienced researcher, an IEEE senior member, and IEEE Change the World Award winner. First, the topic was introduced, which was very well received by PI2. Then the interview guide was presented, and PI2 was put in the position of the interviewee to comment on the questions based on his expertise both on the topic and as a researcher. PI2 then defined MaaS and its associated business ecosystem. PI2 favoured question A2, emphasising that it is essential to define MaaS and its business ecosystem and that “each city and each regulation they see it differently” (PI2).

Regarding question A3, PI2 agreed that analysing relationships is “very important between different actors mainly and between the providers” (PI2). This is seen as necessary by PI2 as it should be a “win-win and positive case for all those actors” (PI2). Furthermore, it is not only important to identify or manage the relationships, but it is “very important also to measure to have some kind of a system” (PI2). Here, PI2 agrees that the relationships between the different actors in the MaaS business ecosystem are crucial to analyse and that PI2 says that his feeling is “that they are monitoring this” (PI2). If PI2 were to build a MaaS solution, “my first concern would be to apply the regulatory stuff” (PI2). For this reason, regulatory organisations are reflected in the actor network, and from PI2’s point of view, regulation is essential as it “allow for the platform to be very transparent to the providers” (PI2).

In addition, cities need to organise mobility so that it does not end up in a chaotic mess. Here PI2 sees potential problems and obstacles that arise when the policies of business ecosystem actors conflict with city policies. PI2 agrees that ecosystem actors need to incorporate regulations into their business strategy, adding that technical regulations such as open APIs are essential: “imagine (name of platform provider) designs their platform, without an ecosystem of open APIs, rest APIs. Then it is going to be difficult, for the integration, right?” (PI2). Furthermore, PI2 sees regulation as critical for customers or users of the platform who want to be insured on their trips.

PI2 then summarised that “all the actors and situations that came into my mind, I think they are you showed me they are reflected on the diagram in one or another way” (PI2). PI2 added that he would suggest shortening questions A3 and B1 as they are too long compared to the other questions. PI2 advises to “condense a little bit in shorter questions and more directly to the point. I think the better for the guys that you are interviewing” (PI2). For the next question, B2, PI2 stressed the importance of describing or developing a strategy, such as a go-to-market strategy for each type of actor in the MaaS business ecosystem. For the main study, it would be helpful to focus on one provider from the MaaS business ecosystem and describe the strategy for this one provider. Concerning question B3, PI2 said: “once onboarding is decided, I think the business model is already decided […], then it becomes technical […]; they need to give me the data that complies with the regulation I am using” (PI2). Data integration will be a crucial factor in integrating the provider into the platform, and if the provider does not provide this data, it could be a barrier. For this reason, PI2’s perspective is “to develop minimum requirements which are needed to integrate the actor in the MaaS business ecosystem” (PI2).

About C1, PI2 stated that he believes that MaaS providers are aware of some of the key issues and have the most critical issues as a template to see which actors are involved and what the remedies might be to address this issue. PI2 compares it to project risk management and says that this document or strategy "should be continuously evolving because there might be some barriers or situations or issues that the MaaS provider didn't pay attention to before so that the MaaS provider learns as he goes" (PI2). That is the main objective of this question, and therefore the need is there. Regarding the external measures asked by question C2, PI2 states that he believes insurance companies influence the network significantly. This is also expected in this question, including measures from legislation or innovation. A final piece of advice PI2 gave on question C3 was to use colour coding to highlight the changes between the case-specific actor network artefact and the future vision based on the literature review. This would make the differences between these two versions much more transparent. Finally, PI2 proposed to patent the idea of mapping the existing MaaS business ecosystem using the actor network theory.

The output of the first pilot interview was a reduction in the number of questions from 10 to 9. The output of the second pilot interview was a refinement of the questions and a change in wording to make them more precise. These adjustments ensured that the questions were well-suited to gathering valuable insights and data from the experts being interviewed. Another learning was to auto-code the interviews using the speaker's initials. Additionally, the pilot interviews revealed that developing individual actor network artefacts based on publicly available data is useful. Finally, some topic language had to be adjusted; for example, Mobility Service Operators have been renamed Mobility Service Providers.

Appendix H: Interview Codebook

Table 61 introduces the interview codebook used for coding the interviews. The indents in the first column present the level of the code.

Table 61. NVivo Interview Codebook

Name	Description	Files	References
Actor Network Theory	ANT was developed in the 1980s by Bruno Latour, Michel Callon and John Law to study phenomena in which both human and non-human actors are in a relationship and form a network.	17	134
Enrolment	Enrolment is the third moment when the other actors accept the focal actor and the role within the new network. Successful enrolment forms a network of alliances, and inscription happens.	16	34
Interessement	Interessement is considered the second moment of translation and reflects the process in which the MaaS provider outlines reasons for the other actors why joining the actor network could be beneficial.	17	40
Mobilisation	Mobilisation is the process in which the actors or alliances establish representatives to avoid betrayal in the actor network.	11	17
Problematisation	Problematisation is the first moment of translation and relates to the process of formulating the problem or network that needs to be researched.	17	43
Characteristics of MaaS	Understanding of MaaS and its characteristics are aligned with the artefact. Nine core characteristics of Jittrapirom et al. (2017) and four characteristics of Giesecke.	17	102
Giesecke	Four characteristics of Giesecke.	17	42
End-User Perspective	MaaS needs to consider the end-user perspective and include different user group segments and acceptance criteria based on individual user attitudes and behaviours.	12	13
Interoperability	Interoperability becomes important as a whole business ecosystem with different mobility providers needs to be integrated.	11	12
Nature of Travel	Their first conceptual characteristic is the nature of travel. In the simplest terms, mobility is about transporting people from A to B.	8	10

Appendix H: Interview Codebook

Name	Description	Files	References
Sustainability	Through MaaS, the environmental impact should be minimised while being economically viable (environmental sustainability), socially acceptable and inclusive (social sustainability), and economically attractive (economic sustainability).	6	7
Jittrapirom	Nine core characteristics of Jittrapirom.	16	60
Customisation	Customising in this context enables users to modify the offered service options to their preferences.	1	1
Demand Orientation	Demand orientation is the user-centric paradigm and seeks to offer the best transport solution from the customer's perspective.	4	4
Integration of Transport Modes	As the goal of MaaS schemes is to bring together multi-modal transportation consumed through a single interface, it is crucial to allow users to choose between intermodal mobility services.	11	13
Multiple Actors	MaaS is built on interactions between different groups of actors through a digital platform, the MaaS Business Ecosystem.	9	9
One-Platform	The MaaS platform needs to be digital, meaning it is consumed through a mobile app or a web page.	9	9
Personalisation	Personalisation ensures that the expectations and requirements of the end-users are met if the uniqueness of each customer is considered.	6	7
Registration Requirement	Having the option that new users can register to the platform.	4	4
Tariff Option	This characteristic is described as having options to choose between different mobility packages and tariffs.	4	6
Usage of Technologies	MaaS platform needs to combine different technologies to enable MaaS.	7	7
Conceptual Understanding MaaS BE	Conceptual understanding of Kamargianni and Matyas (2017).	18	170
Customers and Users	The customers and users are consuming the mobility services provided by the business ecosystem and the MaaS provider.	10	17
Digital Service Providers	Digital Service Providers enable digital mobility services through IT architecture and IT solutions.	18	52

Name	Description	Files	References
Aggregators, Integrators, Brokers	The aggregator, integrator, broker actor is part of the digital service providers, providing enabling technology solutions, applications, and services to the transport operator and the MaaS provider.	6	6
Dynamic Multi-Service Journey Planners	Dynamic multi-service journey planners complement the digital service providers and provide trip planning functionality for the MaaS provider.	9	10
Technology and IT Providers	Technology and IT Providers are part of the Digital Service Providers and deliver IT workloads like applications, with different technologies using cloud capabilities.	4	4
Ticketing and Payment Solutions	Ticketing and payment solutions providers are actors of the digital service providers and supply the MaaS provider with trip planning and payment functionalities.	13	19
MaaS Champion	The MaaS champion provides strong leadership amongst the actors participating in the MaaS business ecosystem.	5	8
MaaS Provider	The MaaS provider is the focal actor of the MaaS business ecosystem.	4	5
Mobility Service Providers	Mobility Service Providers offer mobility services and provide the MaaS provider access to their data using APIs.	17	51
Logistics Service Providers	Logistics Service Providers deliver mobility services concerning the supply-chain and freight delivery.	0	0
Private Mobility Operators	Private mobility operators need to work closely with public mobility operators to offer MaaS. Private mobility operators offer individual services like taxis, carpooling, e-scooter and city bikes, flights, freight delivery and many more.	11	27
Public Mobility Operators	The public transport service provider offers all public transport-related services to the MaaS provider.	15	20
Regulatory Organisations	Regulatory organisations are responsible for defining policies, rules and regulations which need to be considered by other actors in the ecosystem, but most importantly by the MaaS provider.	10	24
Government and Legislation	Government & Legislation can define rules, laws, or regulations for the MaaS schemes.	6	7
International Organisations	International Organisations like the MaaS Alliance or the EU can define policies or standards that need to be followed (e.g., GDPR).	5	6

Name	Description	Files	References
Local Authorities	Local Authorities like cities and councils can facilitate or hinder the development of MaaS with regulations.	7	11
Unions	Worker unions can influence the regulation of MaaS.	0	0
Wider Business Ecosystem	The wider business ecosystem are actors who influence the MaaS Business Ecosystem, but at a distance.	8	13
ICT Infrastructure	The ICT infrastructure actor is a key enabler for MaaS as it provides internet connectivity (4G/5G, WLAN) for smartphones and IoT connectivity to get real-time data from the transport system.	0	0
Insurance Companies	Insurance companies will be part of the MaaS business ecosystem, as new insurance tariffs can for developed for the MaaS provider and the users.	1	1
Investors and Funding Agencies	Investors and funding agencies are exploring the MaaS market and fund arising MaaS platforms.	7	8
Media and Marketing Firms	Media and marketing firms are advertising MaaS and offer third party services in order to introduce the concept to a wider audience and increase the users' acceptance.	0	0
OEMs and Resellers	OEMs and resellers are extended actors of the MaaS business ecosystem. They are responsible for producing and offering a sustainable fleet for MaaS by integrating the latest technological innovations into their products.	0	0
Universities and Research Institutes	Universities and research institutes are playing an important part in the MaaS business ecosystem, as they support its development by researching different parts of MaaS.	2	4
Feedback on Artefact or Study	Feedback provided on the actor network or the content of the study.	3	4
Future Vision of MaaS	Codes and themes derived from the future vision of MaaS.	97	163
Automated Mobility Settlement	Based on consumption, the best price for mobility is derived automatically.	3	5
B2B - Mobility Budgets	In the future MaaS, can be used for companies to give mobility budgets to their employees, which they can use to consume mobility.	4	7
Control Instrument	MaaS can be used as a control instrument of a city to orchestrate mobility.	11	23

Name	Description	Files	References
Fairness (Level Playing Field) and Inclusion	Fairness and inclusion are important considerations for MaaS to ensure that services are not creating barriers for certain groups of people.	13	20
MaaS Roaming	MaaS roaming refers to the ability of users of MaaS platforms to access and use transportation services in different locations without the need to sign up for separate accounts or services in each location.	15	26
Market Saturation and Mindset Change	Market saturation, and mindset change are two challenges that Mobility as a Service MaaS providers must overcome to integrate and scale their services successfully.	10	14
Modularity Inclusion of other Aspects	Mobility just being one part of the future. Make life easy to consume all services.	10	14
Question of Ownership and Certified MaaS Provider	Question of ownership, for example, a government agency can oversee it, but private companies are running it.	9	21
Technical Improvements and Reliability	Technical improvements and reliability are important considerations for MaaS to ensure the smooth and seamless operation of services.	5	7
Tool for City Planning	In the future of MaaS, it can be seen as a tool for city planning using various technologies, systems, or frameworks.	11	18
True Meta App for Mobility	A true meta app for mobility would allow users to plan, book, and pay for their trips using a single app or platform without switching between different apps or services.	6	8
Interview Guide Questions	Case Study Interview Guide Questions.	20	476
Part A	Introduction and context of case environment.	20	92
A1	Please introduce yourself. What is your profession?	20	20
A2	How would you define MaaS and its business ecosystem in your own words?	20	30
A3	How do you identify or analyse the relationships between the different actors within your MaaS business ecosystem?	20	42
Part B	ANT translation, issues, and barriers in the MaaS Business Ecosystem.	20	246

Name	Description	Files	References
B1	After seeing this artefact. Walk me through it and describe the relationship between your company and other actors in the MaaS Business Ecosystem. How would you characterise your relationship with them and see potential issues or barriers?	20	173
B2	How do you get in contact with new actors and get them interested in your solution?	20	31
B3	Once onboarding is decided, how do you integrate/enrol new actors in your network?	19	42
Part C	Strategies to overcome barriers and issues and action plans to scale up the future of the MaaS Business Ecosystem	20	122
C1	Think of a critical situation where you experienced an issue or barrier with an actor in the MaaS business ecosystem. Which strategy did you adopt to overcome the issue?	20	35
C2	Which external measures would support the development of your platform?	20	37
C3	Imagine a future city/world with a perfect MaaS solution. How does this ecosystem look like? Let us walk through your vision and compare with the actor network from literature.	20	50
Questions raised during the Interview.	Questions that have raised in a conversation during the interview.	8	16
Barriers of MaaS	Barriers identified in the different case companies divided into themes.	18	507
Inductive Barriers	Barriers that arise from analysing and interpreting the interview corpus.	18	184
Accuracy of data	The real-time data or other data in the MaaS platform needs to be accurate.	2	4
Commercial Model	Barriers concerning the contractual or commercial model in MaaS.	13	26
Critical Mass	It is necessary to have a critical mass of actors in your MaaS business ecosystem in order to function properly and be accepted by users.	8	13
Flexibility of Existing Commercial Solutions	A barrier that existing commercial solutions cannot be customised or adapted easily.	8	11
Funding	Barriers concerning financing the MaaS platform.	15	34
Inclusion	Barriers for certain groups of people.	10	14

Name	Description	Files	References
Integration Efforts	Barriers regarding the integration efforts of a MaaS solution.	12	30
Liability	Barriers concerning the liability or responsibility for potential fraud.	9	10
Manual Processes not Digitised	Barriers concerning processes which have not been automated and digitised.	6	8
Multiple Apps Already Existing	The different MSPs in the MaaS business ecosystem already have multiple apps, so it becomes hard to get them interested.	7	12
Priorisation	Barriers concerning the prioritisation of features or integrations with actors in the MaaS business ecosystem.	6	8
Volatility of the Market	Barriers concerning the fluctuation of new actors in the MaaS market.	6	14
Policy and Regulation	Barriers addressing policy and regulation.	17	94
Demand Estimation, Creation of Business Models, Tailoring of Services	This barrier is about facilitation the creation of demand and business models.	14	29
Legal Issues, Bureaucracy, and institutional Barriers	This barrier is about legal issues, slow decisions due to bureaucracy and institutional barriers.	11	20
Poor Governance Frameworks, Policy, and Regulation Challenges.	The barrier concerns a poor governance framework with no policies or regulations in place.	17	45
Social and Cultural	Barriers concerning social and cultural aspects.	18	138
Acceptance of Users, Travel Behaviour and Lack of User Trust	The barrier concerns the acceptance of the users, their behaviour or lack of trust.	14	38
Actor Trust Issues	The barrier addresses the missing the trust of other actors in the business ecosystem.	8	9
Competition, Losing Monopoly Position, Control, and Influence	This barrier concerns the fear of competition, losing the monopoly position or power through control and influence.	14	28

Name	Description	Files	References
Difficulties for Users Related to Technologies	The barrier concerns difficulties for users to understand and use the related technologies.	4	6
Missing Collaboration	The barrier addresses missing collaboration between the different actors of the MaaS business ecosystem.	7	8
Missing Leadership and Vision	The barrier concerns missing ideas for a future vision and leadership among the MaaS business ecosystem actors.	8	18
Skills and Knowledge Gaps	The barrier concerns missing skills or knowledge gaps required to build MaaS.	14	31
Technology and Data	Technology and data barriers.	18	91
Data Security and Privacy	The barrier concerns data security and privacy challenges in the MaaS solution.	15	22
Lack of Openness of Data and Standardisation, Data Silos and Interoperability	The barrier concerns lack of openness of data and standardisation, data silos and interoperability.	15	27
Modernisation of ICT Infrastructure, Internet Coverage, Real-time Information Available	The barrier addresses outdated ICT infrastructure, IT systems, internet connectivity and real-time information.	14	32
Unclear or No Platform Architectures Existing	The barrier concerns unclear or missing IT solutions or platform architectures.	8	10
Main Challenges	The perceived main challenges by the participants in their case environment.	14	21
Strategies to Overcome	Strategies to overcome barriers in MaaS.	18	129
Actions (Plans)	Actions and plans that can be done to overcome barriers in the MaaS ecosystem.	15	35
Learnings and Success Factors	Things that have been learned by offering the MaaS solution.	16	66
Policies	Policies that can be adopted to overcome barriers in the MaaS business ecosystem.	6	9
Regulations	Regulations that can be applied to overcome barriers in the MaaS business ecosystem.	12	18
Topics for Future Research	Potential topics and themes that can be investigated in future studies.	5	5

Appendix I: Three Examples of Fully-Transcribed Interviews

In this appendix, three transcribed interviews are shown. Essential aspects of the interviews, which were later used for coding, are printed in bold.

Interview Example 1: Julian Gebhart as JG and I10 (Interviewee)

JG 00:00: Hi (name of participant), thank you for joining me today and for being willing to share your experiences from the (case name). Maybe you can quickly introduce yourself and your role in (name of department).

I10 00:18: Sure. So, I'm (name). I'm the project lead for Mobility as a Service at (case name). So, I am sitting as part of our innovation team there and the (region name) region is in the centre of England. So, there are three cities: There's (city name), which is the biggest, and then (city name) and (city name). But outside of those cities, there are many semi-urban, semi-rural areas as well. It is one of the most sorts of urbanised regions in the UK. But there are some more rural parts as well. So obviously, we have a very varied region and the second biggest city in the UK. So, lots to think about and lots to cover. And my role is to progress Mobility as a Service offering in the region and act as one of the leading regions in the UK, doing lots of research, trials, testing and true implementation, full implementation of Mobility as a Service. So that's me.

JG 01:35: All right, sounds very great that they now see the potential in those regions to develop MaaS. My next question goes into your definition of MaaS. What is your definition of Mobility as a Service and its ecosystem? It would be great if you could define it from your perspective.

I10 01:59: Sure, so I think the key is integration for us. So being able, our users, our customers can plan, book, and pay for their journey. So those three key elements in multiple modes, so both public transport and more private transport offerings like E-scooters et cetera. But a key build on top of that is the integrated back office. So, we don't want to **think of it as the frontend system because the back office is almost where you get a lot of the benefits**. So **having a data-led tool to influence behaviour change means inciting a modal shift and moving away from private car single occupancy journeys into more sustainable behaviours and journeys.** So, the foundation of what we're trying to do is that sort of tier one aim to reduce dependency on private single occupancy vehicles. And then, in terms of the business ecosystem, what do you mean by that? Just to get a bit more concept.

JG 03:25: With the business ecosystem, I mean the participating partners in your solution. Let us move on to the next question because that defines that or gives you a bit more context. So, with the business ecosystem, I mean all the partners participating with you, could be public, private, and so on. So, the question is, for example, do you have criteria, or how do you identify the partners you're working with? And do you have kind of an analysis scheme for that, or do you just go ahead and say we want to have the most important partners included and will be joining later? Or what is your strategy here?

I10 04:12: Good question. So, a bit more context as well. We have a smart card offering in the region, a smart ticketing offering called (name of offering). So, in your research, you can do more research on the offerings there. But essentially, what we're trying to do with MaaS, is built on top of that existing (system name) system.

So, it's the biggest smart ticketing system outside of London in the UK, outside of Oyster. I believe we have a quarter of a million users, so a big number of users already. So that's just a bit of context. So, we already have several built relationships where we have multi-modal agreements with some of our bus operators and rail operators, et cetera. I think, in terms of MaaS, we very much look at it as the foundation of public transport. So, bus, tram, train, and then obviously active travel are also a part of that key foundation. So, walking and cycling, and we also have E-Scooters and cycle hire within our region, so they're also high up on the priority list. I think in terms of other modes, we are also looking to integrate taxi and car clubs, car sharing, and demand-responsive transport (DRT). So, we already have some DRT offerings in the region, and we would look to integrate those. But I think like I say, the f**oundations are bus, tram, train, walking and cycling and E-Scooter.** And then I think, **later on, we would look at some more interesting things, like the integration of mobility hubs, maybe EV charge points, and new modes we don't even know about**. So, it's an exciting time. But we must build the foundation first. And I think in terms of how we identify those. A part of it is looking at who is already operating in the region and has a big market share. So, several journeys to make our offer as full as possible. So, as you said, we did the (name o trial) **trial,** which was good. We **learned a lot, but it's closed now**. We did it back in 2018, and **one of the learnings from that is we didn't have everything on offer.** We had most things, but not everything and **some users didn't want to use it because the thing that they wanted wasn't within the offering.** So, it makes a lot of sense. So, one of our learnings from that is that **we need a product with almost everything we need or that the users need to have a full product** they like. So, and then in terms of prioritising sort of those relationships and partners, it's very much **which ones will hit our aims and goals in terms of integration**. So, we've looked at the **integration of parking as well**. And that might be interesting because you can **incentivise modal shift from parking,** but it's probably not a priority because we must make sure we have a sort of bus, tram, and train in first and things like this. So, I think that's our broad approach.

JG 08:02: Okay, so what I understood was driving the idea to start with Mobility as a Service in the region was that you already had a foundation with (name). You also did then the (name) pilot. And that was then also, I think, the idea to make it bigger and develop such a service solution.

I10 08:29: Yes, so we have a **procurement** which is just being finalised now. We went to tender for a new MaaS solution in the region. So, this is to **tender for the frontend platform**. So, an **app and web-based app, the data integration layer, and a journey planning API so that we can use it within other sorts of technology offers.** So that's what we've tended for. I can't reveal too much more because we're still finalising procurement. But essentially, we're looking to replace some of our existing digital products. So, we have an app today and a journey planner, so this new solution will replace them. So obviously we're trying to make it bigger and better than where we were before.

JG 09:33: That's great! That's great to hear. Also, what I understood is that you said from the (name) **pilot you learned that there needs to be a certain, let's say, critical mass**. I don't know if that's the right term for actors or partners that need to be on the platform so that people start to adopt it. Can you explain, or do you also see that it needs all of them or maybe 90%, that people say, hey, I'm going to adopt it or what is your perspective?

I10 10:05: Yes, I think probably 90% is about right. I wasn't in the organisation at that point, so I don't know all the details, but I think we had a key operator missing, and their service is missing from the offering. So, it was not a complete offering in the region. So that was one thing, but I think another learning was around Marcoms, so marketing communications and that **you cannot underestimate how much you must do for a MaaS product to be successful and, yes, you need a big budget for the Marcoms piece**. So **as authorities we are, we're not used to having digital products that are trying to compete with some huge players**. So, **we must learn quickly in that area and leverage the technology providers** if they have good experience with Marcoms. That was another key learning. And I think Whim was a subscription model. So, I think quite expensive per month for the user because it included any transport, but that was integrated, including taxis, so that you can get like taxis anywhere. So, **I think people in the region were not ready for that model yet, and it came across as quite expensive**. So, I think **in terms of affordability and pricing models**, it's an exciting space with MaaS because we're all still learning. There is no right answer now, but there are many things we can test and try different routes.

JG 11:59: And it's also great that you then have as a city, or as an authority, you have the overview of the different options. With such an offering, you can incentivise different forms better than other forms and kind of control and mobility behaviour. So, do you already see this kind of one objective maybe or not?

I10 12:31: Yes, the paradigm has shifted significantly recently in our region and the UK more broadly. So, in the past, we've been pushing sustainable modes and not mentioning the car. But now we're starting to have a stick for the car. So basically, try to **disincentivise the car more**. We have a **clean air zone** in (name of city) now in our city centre. So, there's a c**harge to drive your car if it's over a certain number of years old**. We also had a **mobility credits trial**. So, we gave people **three thousand pounds worth of travel credit to scrap their cars**. So that trial was with 80 people, and it was separate from our **MaaS work, but it’s something which will inform potentially how we might do things and things we might try**. So incentivisation is very much something we want to do. I think one of the challenges I was maybe going to come on to later is **there are so many options in terms of incentivisation and discounts and rewards and gamification that we need to spend a lot of time understanding** which of those are best for which types of people and which personas and which segmentation and why do they work best for that type of person? So, lots and lots of work is to be done in that area.

JG 14:11: Sure, I can imagine it's crazy. And once you open the toolbox, there's so much in there you can do, so it is great. So, let me take you to this next slide and talk about the challenges you're perceiving now. So, this is a view of your ecosystem that I've built using public sources. And maybe we can start with the digital service provider. So, you were saying you had that (name) pilot, right? And you had some learnings from that (name) pilot. But now I see you have developed your own solution. So you have, for example, Swift, which is for ticketing and maybe payment. But you also have dynamic journey planning. What kind of challenges do you see here?

I10 15:15: I've just put the diagram on this screen because it's a bit bigger. So, I'm not ignoring you if I look over here. So, we have two partners helping us with (us) now and have been for several years, and that is (name) and (name). So, they are sort of tech providers for this, and they were very much focusing on the back office and APIs and things like this. As part of that, an app was also offered, but it was not the core focus. So, as I say, **we have an app, but it is not up to the standard of where we want it to be**. And, those partners are, it's not their bread and butter. The back office is their bread and butter, which they are very good at. So, I think that's where we're at today. And I'm just reading through your question again.

JG 16:33: Take your time. Let me introduce it to you again. The idea is that we speak about the different actors here on a high level, and you maybe name some of the challenges. So, for example, maybe we can go over the transport service operators. When you integrate with them, do you see challenges happening in the integration? Maybe also in choosing the right people to work with. Because some appear on the market, and some disappear. There's high volatility. So what challenges are you seeing with those actors on the map?

I10 17:15: I don't know if you've interviewed some UK parties yet, but **we have a deregulated market**. So much of the time, particularly in the bus world, with bus operators, **we cannot tell them you must integrate a MaaS product or a MaaS solution**. So, it's very much their choice as a business. So that's one of the key **challenges is getting the agreements from several actors to be a part of the system essentially**. And we took an approach in our region. We have a **bus operator, a national express, that has 95% of the market share in the region, so almost a monopoly**. But we have 15 other bus operators with a small footprint, and some have one driver, one person doing the accounts. So, their business type is different from National Express, being a global entity. So, how we must deal with all those bus operators is quite different. And **I think getting those agreements is not very easy.** We took an approach with National Express to try to get them to build requirements for our MaaS products with us. They were part of our procurement process. They were there as an independent evaluator. They **came to our solution demonstrations and negotiations with the shortlisted tenderers. So, they were part of the process throughout**. And I think it gave us that operator view which is important because an authority is just developing **a solution which works for them but maybe doesn't work for the operators is quite a risk.** So, we're happy we took that approach. As part of that process, we also **requested them to transition out of their existing mobile app offering**. So, they have an app which does ticketing and payments. So, we were taking an approach to try and get them to transition from that offering to the new MaaS offering. But I think t**hey were not comfortable agreeing to that because it was based on requirements, tender requirements, negotiations, and solution demos.** And so, I will probably answer one of your later questions now. But **our approach to solving that challenge is to develop the product, develop something which we can show them very clearly**. This is what it looks like because **they were unsure if it could be delivered**

to every requirement we had. One of their **other challenges is the costs they had internally to develop their systems to integrate properly**. So that's another one of the considerations there. But I think **some modes are easier**, so cycle hire is largely within our control. Anyway, internally metro is the same. So, we run the tram service and then E-Scooters; we are just retendering now, **so we can write things like we expect you to integrate the MaaS solution into the contract**. We expect you to do ABC to support the MaaS proposition, and we are taking steps to do that. But some other modes are not as easy. So, it depends on the mode and the different actors within that modality.

JG 21:49: Do you think they are all ready to integrate? Do you sometimes see they are not standardised enough? Or maybe they are not ready from a technical point of view, or do you think that's not the case?

I10 22:05: Yes, we see that. I think, again, it depends on the details of your integration. Because if you have full deep integration rather than just retailing some tickets, then you need to, particularly from a security standpoint, ensure that it's load tested, and app speed is good. Every single part of that system can meet the same requirement at the same level. **But I think some operators are not quite there yet, and some smaller operators are.** We help as part of a managed service. So, I believe we have ten or so bus operators in a managed service, so we will support them with things like rolling out barcode readers on their buses, et cetera. **We use some of our funding pots to support things like that.** So slightly outside of MaaS, but these are all sorts of enabling technologies that would also support this.

JG 23:17: So, are they happy that you're saying, hey, we're building now such a solution, and we want to integrate with you? Or are they feared too? Because the market is getting maybe more transparent for everybody in it and that could result in more competition with another bus provider. Did you see something like that? Or are they more willing and say, hey, it's another channel for us; it's making it easier for our users. What is your perspective on that?

I10 23:48: I think it's been a journey. So, I think it's moved along the past couple of years, and our operators now understand Mobility as a Service and what we're trying to do much better than a couple of years ago. They've seen and heard a lot about it in the industry. I think there is still nervousness **about how it will impact patronage on my mode and my services as an operator.** And other then doing forecasting and very clever forecasting, which we have, we can't prove to any operator that their patronage is going to grow. We think it will happen, but we cannot prove to them that we know for 100% this will happen. There is a bit of nervousness there and a bit of "**I want to keep control of myself, of my piece", rather than sometimes thinking of the bigger picture**. So that exists but is getting better, which is partly why I say we need a good product in the market that we can go and present to say, look, we have X number of users already, this is growing. They want to see your services. The users want to see your services. That is a much stronger narrative than we're hoping to do this and hope to do this.

JG 25:21: That's right. So, your role is neutral as a public authority. Do you feel that helps in building such a solution because you're not one of the competitors or something like that? I think it's perfect if cities or regions decide to do that because they are also thriving and so, and do you feel it's the same or what is your perspective on this one?

I10 25:59: I think I agree with you. I think we're one of the most neutral parties that can develop MaaS, so we have everyone's sort of benefits in mind in terms of operators; we want to grow public transport, want to grow active transport, but where it sometimes gets difficult is the details within that. It's not a terrible outcome concerning carbon emissions, but if the bus operators are frustrated that their patronage is being taken, that's obviously not great. So, when you get into the detail, it's sometimes a bit more confusing. But I think we're very well placed for it. I think there may be some scepticism because we run the metro service and we run the cycle hire. **So maybe some players might think, are we going to try and push that more?** That's not the case at all. **We're going to push all things equally and try to push all the all-public transport and active transport and shared transport.**

JG 27:33: That's right, that's very good. And so, I think combining such a solution with different transport options. There are a lot of regulations, maybe, that you need to follow too. So, do you see something that is maybe hindering a bit? Or would it help if there were a policy that requires all the mobility as transport service providers to publish their APIs? Are there laws that would help you, regulations that you see?

I10 28:16: I think open APIs and standards for APIs and interoperability are improving. I think we see that anyway, but I think we need to continue that trajectory quite quickly. And then the other thing is that **if we can write into agreements or from**

central government to say that operators should be encouraged to join MaaS solutions to integrate, then I think that's very important as well. One of the challenges and risks I see with MaaS is that many people are showing interest now, including operators. So, **there's a potential scenario where everyone has a MaaS solution, but not one is doing very well because there are too many MaaS solutions**. So that's one of my key sorts of worries about ensuring it works properly because we've had some of our rail operators and some of our bus operators interested in developing their own MaaS, which may not truly be MaaS. Just like adding E-Scooters on or something for the first/last mile. It's not a full system, so it's a risk. But I think you're right. **Standards for APIs, open APIs, encouraging operators to join MaaS and for interoperability and supporting technologies are also important**. So, **interoperability for barcodes.** So, for instance, now, in our region, we have different barcodes used for different types of barcode scanners. So, in a MaaS solution context, can you have one barcode that works? I think the answer is you can, but you must pay for software upgrades on the readers, et cetera. So, a particular problem, but things like that enable us a good MaaS.

JG 30:33: Definitely! I also see that data privacy could be quite relevant to tackle. So, for some policies, when you build such a solution, you need to implement them from the beginning. So, for example, did you see any challenges with something like that, like data privacy or maybe liability also concerning fraud?

I10 31:08: Yes, I mean more partners, more parts to the system, more subsystems; there are more vulnerabilities. I think **we have a very low tolerance to risk as public authorities**. So, which is probably a good thing in a MaaS scenario. But what we've found is that things, so things have developed in terms of requirements on privacy and security. We saw the introduction of GDPR a while ago now, but with other expectations. And **as part of our procurement, we expect the supplier to have ISO 27001, PCI DSS, which is a payments protection and** cyber essentials plus. B**ut internally, we're working towards** these accreditations as well, but we don't have them yet. So, it's quite funny because we're specifying the MaaS provider must have them, but our parts of the system that may be integrated may not be up to that standard yet. So, we have the ambition to get there. But this is a sort of constantly evolving piece. And what else did you ask about other than privacy and security? There was something else, I think.

JG 32:53: Now you got me. I'm sorry about this one (no problem). But I agree. So, the regulations are quite important, and you must tackle them from the right beginning.

I10 33:03: It was liabilities, I think. I think it isn't easy in the multi-modal scenario. So, what we struggle with now is that an operator can be liable for their part of the journey across the world. So, if you're a train operator, and the train is cancelled, you must give a refund. But what we should be doing for passengers is providing them with an alternative. But in that scenario, now the customer must pay, maybe quadruple the amount for a taxi or whatever, which is not fair to the user. But we're only responsible for our small part of the journey now. So **multi-modal liabilities are where it gets exciting**. I think we have a lot more to figure out on that front. And not all the answers are there today.

JG 34:04: Definitely. And so, I understand that you are now building up the solution now at the moment. So, I think it's challenging because there's no real business model behind that. So, what you're trying to do is to make it easier for the customers, right? And maybe having done this kind of cultural shift from “I need to have my car“ towards “I can consume mobility easily wherever I want“. Do you see this as a future that people are or should be incentivised by such a solution to consume mobility much more easily?

I10 34:58: Definitely, and I think we need to be quite; there are many big assumptions in modal shifts, so sometimes we think we can discount and incentivise to get people who drive onto a bus. But just from speaking with family and friends, that's quite a big step. So maybe we need to think a bit more sensibly as you go from having two cars in the household to one car, but you still have access to a car club, for instance, or car sharing and taxis. And as a result, you will get some more sustainable behaviours. Because without that second car, and sometimes if you don't want to use car club, you might say, well, it's a nice day today, I might cycle, it's just a short trip. So, as a result, you're getting more sustainable behaviours. So, I think, rather than thinking of a big leap of modal shift, it's more like what are the small steps and looking at the persona types and what works for them.

JG 36:04: Yep. And I think it starts small, and then it will increase as you move over it. So, starting small, I think you are in the beginning with the procurement, but you also collected some experience. We already covered that a bit, but I would be interested: So how do you get the other parties interested? Because of your neutral position? Because you are building an offering, and they are interested? So, what is your strategy to connect with them and get them interested in what you're building?

I10 36:41: I mean, we have several working groups already, so we have operating groups for our smart car solutions. So, any actors that are part of that, which are most of them in the region, then they are a part of that group. So, lots of ideas are put into them. And then, we have a bus operators' group, to which we're taking ideas on MaaS and asking them to enable us to sell things like a day saver ticket across the region, et cetera. So, it almost simplifies MaaS for the user because we don't want to integrate every single day ticket for different operators. We want just one, but we must get an agreement from the operators to go ahead and do that. So, we have those existing groups. I think about new actors and newer models, like E-Scooters, et cetera, it is very much like they come to us a lot of the time. They want to operate in our region. Car club as well. Many car club operators want to set up a base, so more are coming to us. But we must think carefully and make decisions based on whether that brings value to the users. Is it helping us to hit our aims, et cetera? But quite often, we must go through the procurement processes. Well, pretty much always, for modes operating in our region. So, as I said, anything else from now we can write into contracts through those procurements.

JG 38:33: But it's also taking some time to grow. In an ideal world, it would be rather quick. But because of the procurement and putting everybody on board, it takes time. They are maybe also a bit sceptical at the beginning, right?

I10 38:49: Indeed. And I think one of the other things is resources. So, **has that actor got enough resources to think about MaaS properly and has enough upfront resources to analyse constant data coming in once the system is set up, et cetera**? So, they will want to ensure they are getting value for being part of the solution, so they need to have resources for that.

JG 39:21: Definitely! And do you also see that needed skills change? I mean, it's also a war of skills now on the market, right? So, from a traditional point of view, you wouldn't necessarily need somebody familiar with building platforms. Do you also see that this is a challenge that sometimes those skills are missing, and do you wish it is more recognised to build up more human resources with the right skills?

I10 40:01: Yeah, I think something I've found is like the **tech world, digital tech world, financial services world, and transport worlds are being brought much closer together by things like MaaS solutions**. So as a MaaS expert, you need to fully understand digital ticketing and payments, ID verification, as well as the transport system and different modalities and the future of transport. So, there is a lot to learn. There is a, and like you said, **quite a skill shortage**. **But I think those skills are constantly growing, and it's more about behaviours**. So, if you have people in your team willing to tackle challenges head-on and take ownership, then **I think that's more important than knowing everything from day one**, right?

JG 41:02: That's right. And this is also then this mindset needed. This mindset is especially required from the people acting on it. Because the solution, in the beginning, might not be perfect, but I think it's about making them familiar with such an idea and such a solution and bringing some life to it.

I10 41:29: Yes, something we're saying here internally constantly is; because this is a technology project, a technology product will need to constantly evolve to keep up with the market and competitors. You can't just release; you're just collecting data and operating. You must constantly evolve, and I think it **has been a bit of a culture change internally to sort of get on board with that**. But we're in a perfect place with that now.

JG 42:03: Very good to hear that. I also think in the next step, when you integrate with those actors. Maybe they have many more features, or they don't have developed APIs. Do you see there different kinds of maturity levels? And what is also your vision here? Is it easy to deeply integrate with the other actors? So, with a level three integration, or is being loosely integrated at the beginning, or what is your strategy or the issues you see here?

I10 42:29: So today, our app has quite a few modes that are maybe location-based. And then, as a user, you're sent out to another app. So, our cycle hire is location-based. You click it, and then it sends you out to a different app to purchase. So that's where we are today. I think in the future, our new products will be full deep integration. So, no embedded web pages and no callouts to other apps unless necessary or in an interim solution. **But we're trying to avoid that at all costs because of the impact on user experience r**egarding APIs and whether they're ready. Looking at the private mode, E-Scooters and cycle hire are often developed already. It's been a standard in their industry, but **some of our more traditional operators don't have potentially open APIs ready to be consumed externally**. So, as a result, **it can push your time scales back**. It can **increase your cost potentially**. But I think **you must take them case by case** as a scenario. And this is where you **need to have sort of operators that are willing**. It would help if you had a MaaS provider willing to come on that journey and be flexible. And so again, it **comes back to behaviours and culture**. But I think there's a mix when you find out about onboarding; there are mixed readiness levels. Some are ready and can do it tomorrow; some are six months, maybe longer, to go away.

JG 44:38: But it's also maybe to take them on a journey to take them at the hands and say, hey, we create that together, we will take you on board with our application. I think it's always with the end in mind that the customer or the client can easily access the capabilities and start that paradigm shift right from a distributor to a central system where you can control all the mobility options, right? So, take them on that journey; I think that's important.

I10 45:14: Yes, indeed. So, I think we started some of those discussions years ago, so the journey has already been going on for some time, and some discussions we need to start in earnest, but it depends on which operator and which mode. Taxis, for instance, are often integrated through aggregators. We're looking to potentially do some direct integrations with bigger taxi operators in our region, but I think it's over 300 taxi operators in the region. So, **integrating every single one is probably**

a big piece of work and maybe not worth all our time. So, **we must figure out which ones we need to integrate.** Which aggregators are the best, et cetera?

JG 46:16: So, you already look at some abstraction levels, right? One example is that you don't look at every taxi company, but you already look at some platforms that abstract some, let's say, integration now.

I10 46:35: Yeah, and mainly for a taxi. I think a taxi is the main one.

JG 46:38: All right, sounds very good. So, you already named some of the challenges there. But maybe if you think back to the last year. So, what was the most challenging situation you've been in when you were building up the solution, and what was your strategy to overcome this challenge?

I10 47:01: I think the (name) challenge I mentioned regarding the transition from their existing product was a challenge. And the strategy there is to develop the product and come back with a fuller offer and proposal. And then in terms of other actors, I mean our existing suppliers: Well, some development is required to develop a full MaaS solution in line with the new MaaS provider. So, we'll have three key parties for the back office, which has implications in terms of dependencies. Will the MaaS provider have to wait for an incumbent provider to develop a specific API? And then we've spent a lot of the last year or two trying to be ready on technical readiness for a system with those existing providers. But there have been times when progress has been slow, potentially because we've not finished the procurement yet. And also, conflicting priorities because there are existing providers of our technology; we have several things they must address daily, **operationally, and new projects such as capping engines**. Lots of projects are going on, and so sometimes we see conflicts. What is the priority? **Is it the MaaS readiness, or is it the capping project?** Is it for acceptance on rail projects? **Lots of different things going on. So that's one of the challenges again**. The strategy to overcome that, I think, is still ongoing. So, **we must have clear prioritisation; clear communication is probably the key**. And **decisions on our side internally as to what is the priority**. And if we're spending more time on MaaS, which **project is being delayed or put down the priority order**? And what are the implications of that?

JG 49:36: That is good because you cannot tackle everything at once, right? It's huge, and I think you need to start small and then enhance it. And so, I think the prioritisation that you mentioned is important. I also think, what I see from others is, the most challenging thing is to prioritise. What do you start with? What do you add, and how do you do that? And this is also maybe taking to the next question, what kind of external measures would support the development of your platform? So, would it help you if everybody would open or is obliged to open the APIs? Because it is also very expensive what you're building and needs a lot of funding, you need new resources. So, I know that you already have kind of like a sponsor for that. But so, I mean, it might go over that. You cannot have the project finished within one year. The funding needs to be continuous. And so, I'm wondering, is there anything that would help you to support the development of the platform?

I10 51:02: I think a sort of funding settlement. We've **been lucky to have the** (name) **funding, which came from the department for transport**. But most of our funding is **capital funding,** so it's **fine for upfront development costs**. Still, it presents a difficulty with **operational costs and revenue funding, and authorities in the UK at least are well known for being revenue-poor but capital-rich,** or they're not rich but have more than they do revenue. So, there is a **very low tolerance for operational costs, and the perspective now is that we should be breaking even on Mobility as a Service**. But I see in other parts of the world that it's expected there is a cost. So, when you take everything into account in terms of operational costs, we're planning to do the customer support function. We're planning to develop the APIs. There are many development times, resources, and even marketing communications resources. So, there are a lot of requirements, and the cost is quite high in terms of OpEx product management. So, we've tried to build this into our financial model, but I think that's one of the **key messages back to the central government for us is that; MaaS to do it properly, there a cost if you want to do it well, and the funding settlements must reflect that.**

JG 52:55: Okay, so, it needs to trigger that cultural change because otherwise, I mean, it's not there that you invest now, I don't know, a certain amount and then it's over, and everybody will use it. So, it's more taking them on a road map, having the plan to extend it, right? It's a kind of development of it.

I10 53:16: Yeah, and we see, it's getting better in the past, but the funding probably results in people thinking of projects as delivered. And then the operations are not given as much importance, and so t**he operations are not very good in quality or**

not given as much importance as they should do. And, as you say, it's probably quite an interesting relationship b**etween the funding and behaviours of operations**. So, it's getting better, I think. But let's see how we get on.

JG 53:53: All right. Yes, on my last question for you today. So now imagine I put back that picture I just showed you earlier, but maybe you can express by starting from (name), what is your imagination for the future? So, where would you like to develop to? And where do you see it in future, maybe across several regions? The (name) region is also experimenting, which is even bigger. So, what is your vision? How do you see a MaaS developing now?

I10 54:25: I think the vision for MaaS is a very good solution that people are using. It's one where we have **a data-led tool for behaviour change**. So, I mean that in the retail world, for instance, everything is personalised down to a minuscule piece of detail. And in transport, we're not there yet to offer people things that are perfect for them and work for them. And so that's the vision to get to a place where what we're offering **in terms of incentives, in terms of modal recommendations, whatever it is that is personalised and tailored to you as the user**. And obviously, the vision of reduced car usage. We have to get there to hit our carbon targets. Not just to hit our carbon targets but just for the health of the world. We must get there. There's no option not to. And then the other point is on; you link to the data again **but utilise the data for operations and efficiency of operations management**. So, looking at what is the ask in terms of users? What are they asking for in terms of modes, in terms of different routes and come looking at the data to say: a new bus route might be good there, or a new tram route might be good there?

JG 56:03: So, city planning is also right, what you're mentioning.

I10 56:07: So, city planning and planning more broadly. So, link to residential planning and new developments, et cetera. So that's the future. I'm asking for quite a lot, so let's see.

JG 56:20: But it's good to have a vision. Also, some people say that maybe MaaS roaming is becoming important. So, an ecosystem of the ecosystem so that you're moving from one region to another accordingly. So, it could also be, I think, quite interesting.

I10 56:36: Yeah, I'd be interested in **speaking with our central government about this because now we have different regions trying different things**. **But how is that going to sort of match up?** And we know that people's journeys are not just stuck in one region.

JG 57:06: Yes. All right. So, (name of participant), thank you for your time. So, I hope it was interesting for you, and I want to thank you for the interview.

Interview Example 2: Julian Gebhart as JG and I15 (Interviewee)

JG 00:00: Hi (name of interviewee), thank you for joining today and also sharing your experiences with (name of case). So maybe you can quickly introduce yourself and also your role now.

I15 00:14: Yeah, so I'm (name of interviewee). My job title is Senior IT Project Manager. It might have changed this week to the Head of Product Management or something like that. It needs to be confirmed. Most of what I do is interfere with the strategy of other projects and try to bring them into a scope that is more multimodal. So, I'm not a project manager. I am an advocate for mobility as a service. I'm trying to bring around what is traditionally a silo organisation into an integrated transport body from a digital perspective. **We have this goal to become a lot more integrated with** (name of case)**, and I've got the mission from a digital perspective.** It's not necessarily always supported by my colleagues or leadership, so it's an uphill battle to sometimes bring us around. But I joined (company name) about 18 months ago, and before that, I was involved in the (name) combined authority. One aspect of that was introducing MaaS. So, I wrote the MaaS strategy for the (case name) and then joined (company) to lead on MaaS introduction of implementation here. A lot of that challenge is working out. What is MaaS? What does it really mean in the context of (case name)? I've got views on that, which we can go into. I think what's important, perhaps, is to introduce transport for (case name). Is that your next question, or should I do that now?

JG 02:02: No, it's perfect. So, my next question is, how would you define MaaS? And you said there are many different definitions, so it would be perfect if you could explain a bit; what does MaaS mean for (case name)? And what does the ecosystem mean?

I15 02:18: Sure, it's important to understand the role of Transport in (case name). We're a little bit different to other regions in the UK and other cities. So, Transport for (case name) was set up in 2017 by the (country) Government. The (country) government has devolved powers for transport and has devolved powers for passenger transport, not for freight. What? Anyway, so, we, our body that was settled by the (country) government to deliver on policy, so, we, the (country) governments, say what the goals are for transport in (case name) , and we deliver that. **The way we were delivering was to primarily modernise the railway network, and the structure in the UK has been private sector-led commercial operations of franchises for four different routes on the railway network**. Transport of (case name) ran a competition in 2017 for a supplier to operate the trains in (region) , and that was awarded to a joint venture between (company name) and (company name). So (company name) is part of SNCF in France, and they were awarded that contract in 2018. That contract included a total modernisation of the train fleet. So new trains across (case name) that the first one entered service on Monday. So, lots more to come. An 800-million-pound investment in trains, but also an 800-million-pound investment in electrifying railways, modernisation and building new stations. So, a lot of work. So, during COVID, that operation was no longer financially viable. And rather than bail them out with some additional cash, we nationalised the train operation. So, we have taken over the train operation directly within (company name), and we are currently merging the two organisations together. The (country name) government has also then given us responsibility for some bus networks. We've got a national bus network in (case name) that runs between cities. It's called (name), and so that fills the gaps in the railway network. **Because the geography of (region) is a large amount of population in the south of (region) around the capital city of** (city name) **and surrounding towns, the city of** (city name) **and the city of** (city name)**, and then the rest of (region name) is very rural.** There are lots of hills, and very small towns, quite hard to get between places and certainly hard for railways. So, we have a bus network that effectively fills those gaps and provides some connectivity between regions. **We also, as part of our COVID response, where several bus routes were no longer viable, set up DRT, a service called** (service name)**, which is powered by** (company name)**.** And so we have DRT in about 15 areas of (region name) now. Some of those DRT schemes have ended and gone back to fixed schedule routes, but many are very successful and continue. Our role also transports (name) to support the local authorities in (region) . So, there are 22 different counties and cities that are the transport authority for that area. So, for instance, (city), as a capital city, is a transport authority that is responsible for the bus networks in that area. And so urban transport is the responsibility of the regions. So, (city) is our main urban area with a bike hire scheme. It's a docked-by kind of scheme from (company). They also have a car club in the city from (company). So, what that means is we have revenue from our train operations, but we also work with the regions to help them deliver on their goals. So, a lot of regions in (city) are very small, like they have a very small transport capability. They might have one person who's responsible for all strategy, maintenance and data. You know it's one guy, right? So, we provide services through consultancy to those local authorities to help them explore things like setting up bike schemes. I think there are about five regions that are looking at bike hire at the minute. So, **in the context of MaaS and the ecosystem in (name) , we have rail revenue coming directly to us**. We get the fares that people pay for the trains. Everything else, w**e're a facilitator in the market.** And we have a national journey planner called (name), which is a bus and rail journey planner and a cycling journey planner. But no one uses the cycling bit. It's just a bus and railway and provides bus timetables for any operator in (city) because there are 76 bus operators in (city).

JG 07:23: Oh, and are they applied to integrate into this?

I15 07:26: No. So, **they are fully deregulated today, so it's totally competitive.** But tha**t doesn't really work in practice, and lots of the routes are subsidised**. The (city) government is going to change the market for buses in (city) and go to a franchised approach, so we are mobilising to take control of the bus network. And the operators will, instead of being responsible for the full service and fair revenue, they will be paid a fixed amount to run a bus from A to B, and we're responsible for all the brand and all the retail and the design of the network as well. **So that is going through the (city) government next year, and then because of that process, they will then be obliged to be part of MaaS.**

JG 08:16: Okay, right.

I15 08:16: So, it's not for us to today, and a **lot of the regions in the UK, like in** (region)**, they have to make negotiations with all the local operators for the ability to sell their tickets**. And that's hard, especially when we have 76 operators. So, we don't want to do that yet. **Instead, we're going to focus on journey planning first as almost a level one MaaS. I like to use for level one Jana Sochor's topology of MaaS**. Yeah, so **we focus on kind of levels one and two.** So, information like schedule information and fare information. So yeah, **we can publish the different fare rates, but we won't get to any deeper integration like ticket sales or journeys until that franchising process has been implemented.**

JG 09:08: All right. So, you really start with, let's say some information combining different information but not integrating it. So that comes then later.

I15 09:24: So, **one other thing is that, when thinking about MaaS, we're thinking about who our audience is already and who's using our services**. So, we have **four mobile apps today**, one for (city), one for (city), one for the national journey planner, and one for rail ticketing. Rail ticketing has the largest audience. That's the area where we will expand upon that platform because everything else is SaaS. So, like the (name) platform of software as a service, the bus ticketing platform from (city) is software as a service, **so I can't really modify them**. But our rail app we've built with a local digital agency, so we will build out from that platform and from that existing audience. And so, from the start, it's how do we help rail people, make rail customers, make better door-to-door journeys and then attract bus customers to use that as well. Effectively, we will overtake our national journey planner. So, we've got this, like the (name) company app will be retired, and we'll say now use our single Transport for (city) app, which has all the journey planning capabilities. So, we're bringing the bus customers into it for journey planning. But one thing to be cognizant of is the number of customers that use our apps. Only five per cent of rail customers use our app, and only one per cent of bus customers use the Travel Line app for journey planning. So, we don't have the whole transport audience in (city). Part of the reason why is that there's a company called (company). They sell rail tickets in the UK, and they have an app. And they are the household name for rail tickets because they did digital rail tickets before all the operators did. And they spend a lot on advertising. And they have most of our customers. So, we've been thinking of; **we've been trying to play catch up with (company) and almost replicate all the same features with our rail ticketing**. **What I'm looking at is how we differentiate from (company) and offer a different value proposition for people in (city).** We will still offer rail ticketing, but we will **offer it in a more tailored way, suitable to local audiences.**

JG 11:45: Yeah, all right. I understand that. And so, you're starting really from the rail perspective. So, you're coming from the rail perspective and then thinking about how can I bring now value to that? And that's, I think, perfect. So, it's leading me to the next question. So how do you identify, for example, how you're working with new actors or how do you then expand? So, what is your plan in analysing first? I mean, you need to identify how you're working to grow it and to develop a kind of solution or something like that. Do you have criteria for that? So, how do you approach that?

I15 12:21: Yeah, so one of the things that we've been doing, so building out from this rail audience concept is: So, we've been looking at the passenger flows on key routes. Because our train operator isn't just (company). We're called Transport for (city), but we run to (city) and to (city) and to (city) and to (city) and to (city) and (inaudible) and other big places in the UK. And in the UK, it's like in England; there are lots of last-mile options that range from e-scooters to bike hire. I used to bike hire in Manchester yesterday when I was there. There are a lot of options in England for the last mile, but within (city) outside of (city), there aren't really any options. It's a bus and, in some places, (city name), the DRT service. So, one of the things that I did was take a list of all the stations that our trains run to, 200-250 stations that we run to. And in each of those areas, I identified the different last-mile options, first mile and last mile. So, for a town, does it have DRT available? Does it have a bike hire? Does it have a scooter hire? Does it have buses? That we've got a product called (name of product) bus that allows us to sell a bus add-on ticket onto the rail. Does it have a transcoding network there? Is there a ferry service that connects there? So, all these, like, what's the level of integration in each town? And then I looked at; what are the number of ticket sales on the rail today in each of those towns. So, where are our main customer flows, and where are the most integration options? It's to say to target multimodal journey planning and multimodal rail in those areas where customers do have options where we can offer something in the space. For a lot of areas in (area name), in North (region) places like (city) or (city), there's bus and rail, and to integrate that in a MaaS platform with a whole wealth of options saying, hey, did you know there's DRT, but there isn't. Look at the bike options, which there aren't any. Y**ou know there's a very different user experience and value proposition in those areas versus a comprehensive MaaS platform**, **and we need to work out through our design how to tailor that user experience for wherever you might be for the types of journeys.** Because we talk a lot about having one platform and everyone coming to Transport for (name), it's different a Transport for (name), depending on where you are, and we need to tailor that value.

JG 15:09: Yes, that's right. And I mean, if you're speaking that there are a lot of different players involved, local players, you need to think about how you integrate with them, right? So, I mean, you started, maybe first to display their information, to say hey, they maybe have then a link. That would be, I think, the first step, but then, of course, maybe to have a better commercial model with them. So that you can offer tickets and you can maybe have a deep integration with them. So, what would I like to do with you? So, I don't go into detail now about this map, but this is a map I created from the literature about players who should be part of an ecosystem of MaaS. So, you would have something like transport operators where you have public operators, private operators, maybe also logistics or freight, however, you want to call it. Then you have Digital Service Providers, Aggregators, Journey Planning, Ticketing, and regulatory bodies. So, like the local authorities that you mentioned, the government legislation and so on, all of them influence the network. So, what I would be interested in doing with you is that you can maybe talk a bit about or walk me through a few challenges you see and maybe start with, because you started with that already with the different, let's say, players on mobility and local mobility that you want to integrate from the point of view of rail. So, what do you see as the challenges? Are they maybe technically not ready? And they need to first describe or maybe modernise what they have. Or maybe the commercial model is a big challenge. Or is it more that they don't have the skills already to do that with you? I don't know. So, I would be really interested to hear from you about what you see as the challenges there.

I15 17:06: Yeah, our **main challenge is we've run out of money**. We're as I mentioned at the start, we are building some railway infrastructure modernising the railway infrastructure, and material costs have gone up. The cost of labour has gone up, and now we need to finish that project so that we can run the new trains because they're all electric. So, we need electric wires for running electric trains. So, a lot of the funding is being prioritised towards that objective over the next two years. But that aside, we'll deal with the money; the money will come from somewhere. The main challenge that we have, I think a couple of things. Looking at this diagram, all of them are largely okay in (region). I mentioned that we've **got the regulatory landscape. That's going to make it easier to integrate bus operators.** There's also a policy in (region) to expand something, I didn't mention. We've got a **national transport strategy in (city). Yeah, that is looking to expand shared mobility in regions across (region).** So, as I say, we're going to, there's going to be a lot more bikes hire available in different towns, expanding car clubs, expanding flexi services. So, **the landscape of mobility will be changing.** So, I'm almost looking at MaaS before the landscape changes. Yeah, and almost, it's about to launch rather than go; it's like a lot of things like Berlin with Jelbi. **There's already this shared mobility landscape, and they've added MaaS on top**. With MaaS as the platform to enable.

JG 18:54: Yeah, and they must apply for it to be part of the platform, and you are more looking then for who you can cooperate with. But I would also be interested: So why do they now see it as a priority to have that landscape as well? Because before there it was maybe not allowed or, but now the minds are changing a bit, right?

I15 19:13: Yeah, I **think it's the strength of the (region) government's goals to take control and intervene in the transport market,** to make it more integrated and more accessible to people in (city). (country) is a very deprived country. It's got a very low GDP per capita. So, the role of the (country) government now is very much around; How do we improve the chances of people in (country)? We also have a piece of legislation in (country) called the **"well-being of future generations act". And it's a piece of social legislation that ensures that we do our best for the next generation of people in (country) from an environmental perspective, preserving culture and providing access to job and employment opportunities and training.** So that it basically frames our policy goals to say we're here to do good, we're not just here to make money. So, yeah, that kind of this sets us on this path of better integration within the transport and better integration across public services. So, one of the things in this MaaS ecosystem I'm very cognizant of is; how we integrate with the likes of the health service in (city), libraries and museums. When you go on websites today, you always have some information about how to get here, and they're like, here are some bus routes you can drive by coming on this road. There's a train station nearby, and it's very static and not very helpful. Yeah, so one of the things I'm thinking about is better integrating our journey planner into their platforms. We provide a widget today, effectively a search form that comes over to us. But they are very interested in it. Let's embed that journey-planning experience. Even if you get a hospital appointment in future, you get an automated email from the hospital saying your appointment is currently. That appointment could say if you're travelling from home, here are the options for you to get here at this time. Because we know where you live, we know where you're going, and so it's planning that public transport journey for someone before they've even thought about their options, you know, make it super personalised to that appointment from their home location. So, I'm really interested in that, like long-term integration. Yeah, I think the thing t**hat's missing from this one, and our big challenge that would come back to your challenge, is the customer**. It's actually over there. But one thing that we don't know is; what do our customers really need? Do they really want a multimodal journey planner, or do they want an excellent rail journey? Or an excellent bus journey planner? And are we doing enough for our rail customers to get the most out of rail? You know, should our priority be integrating plus with rail, or should it be making sure that rail works as effectively as it can for its existing customers? So, in (case city), we've got some analysis about the number of people who are travelling greater than five kilometres. So, we did some analysis for any journey greater than five kilometres to say that the origin and destination are near a train station, and 11% of the long journey over five kilometres are near a train station at the start and finish. So, they could be done by rail. If someone lives nearby and is going somewhere nearby a train station, rail could make up to 11% of journeys. And today, it's only about one per cent. So, there's a large number of people who aren't using rail. And is that because of the lack of integration with the bus, or is that because of some other reason? Is it pricing? Is it the service frequency? And how do we start to get those insights for making each mode the best it can be, not just integration? And so that's that prioritisation that I need to work through, which is, **do we prioritise improvements to our rail app for rail, or do we improve our prioritise improvements to make it multimodal?**

JG 23:23: Yep, right. And maybe it's also about being easy. So, I mean consuming it in an easy way. So, the usability of it, because I mean right now it's maybe not as comfortable. That might also be another, let's say, factor for that. But yeah, I mean, if you look on the customer side, it's for them; they will use it if it's easy for them to use and if they see somehow a benefit in using it over something else. Yeah, and I think, first of all, you need to get this offering, right? In an easy, consumable way so they can start to adopt it. But of course, it's kind of a chicken and egg problem, right? So yeah, you want to know what their customers want, and they want a very easy platform to be consumed that fits their needs. And I think this is a challenging point as well here.

I15 24:13: Yeah, so one thing I haven't mentioned yet is that our retail proposition in (case name) is going to move towards a pay-as-you-go model. **So, post payment using your contactless card or mobile phone to tap on and off at the start and end of a journey and have a weekly fare cap. So, you never pay more than you need to.** And this will be across bus and rail in our urban and metro areas. So, for 74% of our customers, about half of our rail journeys, we'll be able to use pay-as-you-go in future. So, selling rail tickets and bus tickets is not something that we really want to go towards. **Because we don't want people to buy a ticket, we want people to trust they're going to get the best value fare and the convenience of tapping on and off**. And so, then you look at the retail proposition in MaaS, is that necessary? So, what I'm thinking about is when we come to the retail of, let's say, bike hire if we are to integrate bike hire into MaaS, is it better to integrate bike hire into pay-as-you-go? So that if someone uses bike hire in the MaaS platform, but they're instead not paying for the unlock fee. **But the unlock fee goes into their total weekly fare cap of saying if it's a maximum of 15 pounds a week**, if you use a bike hire, that's just part of the same maximum flat. **It'll need complex**

commercial agreements to put that in place. But that's more where we're thinking about the convenience and integration as part of the pay-as-you-go retail rather than just ticketing.

JG 25:55: Yeah, so you consume it. So, I always use that as an anti-example of mobility as a service. So, if you imagine, for example, if you're buying a ticket here in Germany, there's a huge, let's say, cash machine with 1 000 buttons, one thousand different options you can buy depending on where you're going. How many zones do you have, and so on? So also, for a German, it's very hard to understand. And why do they make it so complicated? Why do I have, as a customer, to choose from the tickets? I want either to have an "abo" so, which is a monthly amount of money I'm paying for it, or I just consume it, and in the end, it will give me the best option and what I have consumed. And so, why should I choose as a customer for it? I think this should be the future as well (yeah). So now when you're starting this and now when you're like, I mean, you know, also planning the commercial models and kind of everything like that. So, do you see what challenges may be in terms of technology? So, are they all ready for you to integrate? Do they have, let's say, their APIs open? Do they have, let's say, the right infrastructure to support that? Or do you see there is still a long way to go, and you need to maybe start a bit smaller and then expand it or help them to modernise? Or what is your view here?

I15 27:25: So, we have already ensured that every bus in (city) of all the operators has an electronic ticket machine that can accept a QR code ticket, and a mobile ticket, except for one bus operator, which is (name), because they work on a different technology platform than the rest of them. **We've got them harmonised by**

using the same supplier's technology with an API available. So that's great. So, we've got the buses sorted. Rail is sorted because there are national back offices for rail ticketing. It was set up in the early 90s when they went to a franchised rail market. So that's open. It's hard. **There are accreditation barriers for selling rail tickets that you must go through**. It's a lot of effort. Makes costs half a million to become an authorised retailer or partner with someone else who already does it. So, we've done that for our own app already, and it's painful. So, we've done that. **We know that bike hires like** (company name) **is available with APIs and have been integrated by others before.** So, Jelbi got the Next Bike. That's great. And Jelbi has the whatever it's called "Mover"? I can't remember. They changed the name recently for their DRT service. It's powered by Via, so we know that (company name) has an API, but they did bespoke the API, and Via needs to launch a new API next year. So, we know that integrations are available. **I found some barriers that some suppliers want an NDA in place before sharing details of their API, which I just found a bit weird**. Because then I look at, yeah, like it's good companies like Voi, and they've gone. Here's all our (inaudible). Oh, and really, how proprietary is your API, you know? But yeah, we've got those from a technology perspective; they're able to be integrated. **I think that one of the challenges is our internal IT systems and our internal way of working.** We've built solutions to solve problems like our customer relationship management system that was set up for rail and will now need to become multimodal. We have set up a transactions database, which is only for rail and will now need to become multimodal, and I look at a lot of the MaaS platform providers. Yeah, the names, you know, l**ike (company name), Instant System, and Iomob, and they're all offering the whole solution, and we don't want the whole solution. We've already got part of it, and so the**

complexity we're going to come to is; how do we choose a technology partner? Because of it, the advice on hacking on over (company) or Instant System? They will already have most of the solution, but then it will be more expensive for them to adapt their solution to work with our in-house back office. So, our strategy for MaaS is more going to be; **we need to buy that capability from that supplier, that capability from that supplier and build it together,** and I prefer it that way because we have a lot of ambition that goes beyond what a lot of the market can offer. **Lots of the suppliers can address 80% of our requirements, but no one's got the full solution.** Like some might be great at 30%. So what? And another might be great at a different 30%. And I want the best for everything.

JG 31:07: Yeah, and that's a very valid perspective. Also, I don't know if you know that, but here in Munich with MVGO, they also started with (company) as the backend provider, but now they have chosen to develop it on their own because they have the same argument that you said they want to have the best of everything. I don't want to be too dependent on somebody. And it's also expensive, of course, and they have their own capabilities to produce that. So, they want to buy different parts. So, I think it's a valid point of view to have that. I think you mentioned two points. Number one is those NDAs which are kind of strange. Do you think that could be caused because they think there could be competition? If the competition somehow sees how we are doing it, could they learn from it? So that's my first point, and the second point is regarding skills. So, do you think that the public transport and rail operators have the right, let's say, team in place? Because, right, they come from a traditional authority with a different background. And now they are moving into this platform business. They need new skills, developers, designers, IT architects and so on. So, it's a totally new world for them. So, it would be great, if you can, maybe comment on these two points.

I15 32:30: Yeah, no, we don't. So, we have a small developer team in the house of Transport for (city). **Our director thinks it's bigger. We can build that in a month.** They're already busy, but we did our own website. That was to start our own website in-house. I think for a lot of companies, you know, even in the commercial sector, they don't have, not even outside of transport. **Digital teams aren't something that they're necessarily maintained in-house, and they don't make a constant investment in digital**. And so, **I think it's about a lot of MaaS companies selling a SaaS out-of-the-box platform that has been able to work with cities with no digital capability and transport operators with no digital capabilities. So, they just want convenience.** And in a lot of those places, they don't have customer insights and the ability to do user experience design as well. In the Transport of (city), we have a small capability, but we're aware of our gaps, so it's about choosing the right digital agency to work with us and give us that capability to become a bigger team. So, and that isn't just from a; I think the way it works, like if you look at our current rail app that we launched last year, it was done with a software development house, and so they've built the software that we asked them to build, and they did a good job of building the software that we asked them to build. But customers don't like it, and our staff don't like it because they didn't do the design and the research; **they didn't think about the whole product proposition;** they just went straight into it. Ah, you want us to build the formula they can have; origin, destination, and the number of adults. There you go. Here it is. We delivered it, and then our testing went; well, it works, and then we release it to customers, and then customers go.

Well, what is this? So, yeah, it's the maturity of the product design aspect. I think it is, yeah, an important aspect, not just of the software development capability. But yeah, see cities, transport operators, I don't think they have that. I think they're starting to develop it more. LNER is a great example where they're doing their own bespoke train app and really thinking about what the customer proposition is. I think they've got a digital agency doing it for them, so w**e're not just looking to buy MaaS technology but a partner who can do the integration for us as well.**

JG 35:21: Yeah, that's what I also observed; I don't know if you know (case). So, from (city). So, in (case), they had this (name) initiative, and there they also did a pilot, I think, for two years now and that now they stopped. But they said the insights generated were good, and now they think about how we can do it on our own, which partners we need and so on. So yeah, like many different cities they are now starting to think about that. And yeah, also, what you mentioned now with (city), or I think (city). I think they are using (case).

I15 35:58: Yeah, yes. So, I worked for (company) on the Smart Rail 4.0 program, and then they let the domain name run out, and someone took it and hijacked it. (Case) has been hijacked by someone else. I didn't realise that the scheme had ended. Also, (case) did a trial with a company called (company). It was for a thing called (case), which is, again, another door-to-door journey planning and (company) have launched a B2C miles app in (city) called (case), which has also launched in the UK now. But they haven't told anyone. But it's available in the UK, and I think it's a great rail ticketing and taxi platform. It doesn't have a bus yet, and it doesn't have other shared mobility, but I think it's one of the best rail ticketing customer experiences on the market. I used it yesterday to buy a train ticket because I needed to. I didn't want to use our own app. I'll get mad (both laugh).

JG 37:13: Yeah, but yeah, I mean interesting. And I think each city, they see the potential, now they are starting to develop now they're making their own experiences. And I think mobility always happens locally or maybe in regions, but it's different everywhere. Some things are common, but certain things are then different. And the maturity, of course, is different everywhere. So, I think there are some of the main challenges now. Yeah. So, before we move to the next question, is there anything else maybe that you see as a challenge that you want to speak about?

I15 37:50: **The slowness of the public sector, like the number of people that need to be involved in every decision. So, clear accountabilities for MaaS and transport integration.** It's not clear in **Transport (case), it's not clear in the (region) government, it's not even clear in UK Government who's responsible for integration**. A lot of the **policy teams work in silos**, so in Transport (case), we have a bus team, an active travel team, and rail teams, and then **we don't have a team that's looking after integration.** So, there are a lot of stakeholders. I equate it to like when 10-year-olds play football; everyone's chasing the ball. So, everything must have ten meetings before everyone's happy with the decision, and then every meeting is like 10 to 15 stakeholders, you know, and everyone has their view on what's best. I**t's that lack of clear accountability, like who's responsible for business outcomes. It's so slow.** So, there are a lot of hearts and minds. That's mostly why **it's taken 18 months to go from starting here to the business case of people being ready to trust me**. And, of course, trust that this is the right vision.

So, and a lot of that is just been through persistence, perseverance, being here long enough that you know people trust what I have to say and see me as an expert at that. At first, it was quite hard with other people. But so much is based on people's professional opinions. Mine too. So much about my MaaS is based on my own personal views. **We don't have a lot of evidence to back things up. And I think as we mature our customer research and insights capability, we've just hired five people in** that space. We'll have more customer evidence on which to base decisions and move away from it being people's opinions to more; this is what the customer's asking for. The customer needs not just what they're asking for but what they need, you know, with deeper insights.

JG 39:59: Yeah, but maybe, it's about political discussions as well, but maybe they don't understand the value, or they don't really, or they don't know how to start. And I think that it needs experts like you. **So, experts who can then tell them, hey, the technology is there, you could start with this, and then they start to trust you and say, hey, you have the experience. So, I call that sometimes a MaaS champion.** So, these leadership kinds of capabilities. So that you are championing basically your organisation, your provider **towards a, let's say, the north star.** So, the vision and that you have the credibility to do that. Yeah, so I see it as a very important thing to do.

I15 40:48: Yeah, I pasted a YouTube link in the chat to something you'll enjoy: the video of the (case) when they launched it.

JG 40:58: All right, I will look at it.

I15 40:58: It's a Rube Goldberg machine. Do you know what that is?

JG 41:05: Yeah, I heard that.

I15 41:05: Yeah, it's cool, but related to the comment that we just said, the d**angerous animals of product management** is an enjoyable read. So, the types of different people who get involved in product design are often **hippos, the highest-paid person opinion.** There's a lot of that.

JG 41:22: Okay, good, I will definitely look at that. These are very good resources.

I15 41:27: I'm doing a university course in product management at King's College London and have been doing that for a long time. It's not a full degree, but part-time for six months.

JG 41:35: So yeah, so great. Yeah, so let's get back to the topics. So now we cover most of these questions. But maybe you can summarise a bit more the main challenges. So now, when you contact them and when you're not building up your solution, you need to somehow get them interested in joining your solution. What do you see as the main challenges here?

I15 42:00: The main challenge for me is; I'm the MaaS advocate. MaaS is a digitally based solution. I am in IT and digital. I do not have direct relationships with the transport operators, and when I reach out to them often, I can upset my colleagues. So, in terms of actors, there are some which whom I have an open relationship, like the shared mobility providers, **where we don't really have someone championing or expanding shared mobility in the transport of (case) or others**. You know, if I reach out to Enterprise car club, it's fine. If I'll reach out to the bike companies, it's fine. **But the bus operators are a very sensitive, politically sensitive space, so I don't speak to them directly unless one speaks to me.** I make sure to use my internal colleagues for more of the commercial and appreciate the wider sensitivities in that space. I'm focused on; how we build a great digital solution and who are the partners I need to be on that. So, MaaS, I'm advocating it as a digital-first solution, and it's gradually bringing more and more people into the business into it. So, I've now got a project team that includes finance and commercial and others. But it's to build them the digital element of MaaS and isn't necessarily the; it's starting to become a company-wide movement. I think at the minute because we're still at the business case stage. It's perhaps I haven't needed to go and speak to them deeply to establish a commercial relationship. At this stage, we're still just kind of working on strategy and business cases.

JG 43:50: Yeah, all right. So, in the first steps, but then, of course, I think you need then a different target, or let's say, a communication type for different providers (absolutely). So, as you said, it is very easy to contact them, and they are happy to cooperate with you. Others are a bit reluctant, maybe because they are afraid, they don't know what the technology is, or they don't know, they don't have the resources to support you. I don't know.

I15 44:16: So, the biggest factor that I needed to be in touch with and get on board, first was our internal team in rail. Our rail ticketing app was built by our rail retail team, and I needed, or we needed to take that up and change it to be multimodal. And so there were a lot of different stakeholders to bring on board f**rom a rail background, and some still are very sceptical about the solution there.** So yeah, took a long time ago.

JG 44:51: I can understand that. Yeah, and it's also then the last question in that area. So, regarding I know you are still in the concept phase, so you don't have onboarding already finished. But I think you spoke a bit about the strategy you want to adopt when integrating or enrolling actors in your network in your solution. So maybe you can talk a bit about the challenges you see here or your plan or your strategy.

I15 45:18: Yeah, I tell you, what going to be interesting is an area that I'm thinking about with our rail operations that (city) and borders, that our trains run to (city) and (city) and (city) and other areas. So, there's an element of MaaS that's beneficial within (region). Okay, for last-mile travel, but a lot of the rail journeys will start in a different city. I was in (city) yesterday and so do we look at the integrations in every place that we go to, and how do we do the onboarding and integration there? And so, I was looking for a lot at the last mile options. So, which by (company) is available in (city), for instance, but then I thought, the main integration is perhaps with the tram network and perhaps with the local metro network in (city). And they don't necessarily have interoperable ticketing or APIs. It's the bit that I forgot about was traditional public transport. How do we integrate with public transport in other **cities outside of (region)? So, I had a look around, and that's where the APIs may be lacking in those areas.** So, I'm hoping that (case) in (city) and colleagues in (city) will fix their MaaS so that then we can borrow. So, I'm very interested in going; **how do we widen our MaaS ecosystem so that we integrate with others and borrow the commercial agreements and APIs from other suppliers?**

JG 46:59: Yeah, and as well the learning, so that you can have maybe a consortium at least. It doesn't make sense that the worldwide consortium and even EU-wide, might be too big. But suppose you have a local or regional consortium where you meet maybe twice a month, monthly or quarterly, whatever you sit together. And discuss your challenges and maybe build an ecosystem of ecosystems. So, this means you combine different options with each other, learn from each other, and synergise.

I15 47:30: So yeah, I already **run a meet-up of 14 different cities around the UK exploiting regions exploring MaaS, which is how I know (case) and others**. Yeah, so we run, we run this **meet-up to exchange ideas**. But yeah, it will become more of a; there is an opportunity to formalise that ecosystem, as you say in the ecosystem of ecosystems.

JG 47:56: Yeah, very good. And yeah, so this is my last question in that. So, I have three more questions, but they will be quick. So C1 is now about a bit about a critical situation. I call that it doesn't need to be critical; it can be a challenging situation. So, what is the kind of the most challenging situation you see now to make it work and what is your strategy to approach this?

I15 48:25: **One of the main challenges is there are certain stakeholders in Transport for (case) and within the transport community that don't think we should have our own app and we should just let the commercial sector lead**. So let Google Maps lead on journey planning, Apple Maps, City Mapper, and whoever else in the mapping space and let third parties like Trainline.com be responsible for rail tickets and other alternatives like trade pal and things, but we shouldn't have our own apps. That's a big argument that it's hard to shut down because it's very much based on opinion, and I have an opinion that differs from it. But I also support it because so many of our customers use these third-party channels; you know, I always use Google Maps. I use City Mapper. When I got to (city), I used these alternatives. I use commercial platforms, and so do many of our customers. And so, we want to be able to provide excellent information through our own open data to those third parties. **At the same time as trying to have our own platforms and attract customers to our own platforms where I believe we might be able to get more lifetime value. Ensure that there's 100% coverage of transport options in (city).** So, for instance, Google Maps doesn't have the Next Bike in (city); despite me asking them several times, you know the commercial providers aren't prioritising (city), so there's an opportunity for us to do so. But eventually, if we get around to it, and so we need to be patient. But also, once we own the customer relationship. Then we can start looking at how we personally do personalised marketing to encourage more travel and improve the customer's lifetime value. So yeah, **that's the main challenge, that philosophical view of just letting the commercial sector do it.**

JG 50:34: Yeah, I agree. But at the same time, I also disagree that Google needs to maybe lead that. So, I think everybody, and every region can lead that on their own. They can build their own data foundation, their own back end, or maybe a data lake or whatever or middleware. **So, you're creating an IT artefact, an IT architecture which is then capable of either feeding into your, maybe, your own mobile app for your needs or feeding them into Google Maps. And maybe then you also have a commercial model with Google with Apple**. I don't know, but getting this platform working first is important. **And I think that's where your business is also and where you're where you can bring value**.

I15 51:31: The other thing that we have to do is make things available in the (country) language, and commercial providers like Google Maps don't support (language). Microsoft does, and Bing Maps supports (language).

JG 51:43: Yeah, but nobody's using it. Yeah, that's the thing.

I15 51:57: So, this is for things like wall street names, the (city) names of places, schools, hospitals, they all have a (city) name, mostly otherwise name, and then we're looking at going advanced features like turn-by-turn directions, and you go well, how do we do text to speech in (language). Because there aren't many platforms that support that. There are a couple of good ones now, but it's an area where when I look at a SaaS platform like a solution from (company) or whomever. I know, (company) doesn't want to be truly SaaS anymore. Lots of the providers, but when I look at those, I go, well, I can't use Google Maps. So, you need to change the mapping platform for any type of directions you have. We need to make sure it has street names from an alternative data source. We need to make sure that the text-to-speech, whatever engine you're using, we need to change it to one that supports (language). So, there might be so much change that the (language) forces us to build bespoke.

JG 52:59: Yeah, definitely. And so, second last question for you today.

I15 53:06: **Oh, one thing that might be interesting for you to know there are more people who use our website in German than they use it in (language).**

JG 53:09: Really?

I15 53:14: So, they have their browser or app set or phone set to German. More people are set to German than are set to (language).

JG 53:22: Interesting. But that also means that tourists or people who are visiting the area from Germany might use it the most, right?

I15 53:31: So yeah, interesting. Yeah, but we don't support you in another language because you speak English anyway; it's fine.

JG 53:37: Yeah, that's right. But I've been to China, and they did not support English or any other language. And you had the app, and I had a second phone, which then did a live video translation of the app in Chinese. So, this would be the worse.

I15 53:55: But yeah, I used to live in Germany. I used to live in (city). Yeah, but I never got to learn German because I worked at (city), and everyone spoke English all the time. And yeah, I was still at a University, I was still a young student, and okay, I got by when I spoke in German to someone, and they just responded in English.

JG 54:27: So yeah, sometimes. Yeah, all right. So, my second last question now for you. So, anything I call external measures so, meaning for example funding, you said that might now be a bit of a problem, but not in the long term; you will fix that, but if others are obliged per law to have an open interface, an open API, I don't know. Is there anything external that would help you?

I15 54:54: Yeah, regulation in the **EU, there is some new regulation coming in to make it so that all public transport operators must make their ticketing open.** I think that will be **useful in the UK in the bus space**. **Because if we want to integrate bus ticketing today, we need to make a different agreement with every bus operator.** Yeah, I mean, it doesn't necessarily need regulation in the UK to achieve it. Could be done by just getting all the partners around the table and getting an agreement jointly in place. I think, however, that will give the bus operators a lot of power in that negotiation and not a lot of power to the cities. So, I think there is a role for some regulation to open ticketing in the bus space because the bus space is fully deregulated today in the UK, whereas in the rail space, they did do the open ticketing strategy. You know, back in the early 90s, they created, I think, a lot of the systems still run-on mainframes. **So, they've already opened the ticketing space in rail, and that's been beneficial.** So, you can use any train operator's app to buy any train ticket from anywhere in England to anywhere else. So, you can use the Transport for (case) app in Scotland, for instance, and still be able to buy most of the rail tickets. So that's already been solved. **But yeah, that lack of regulation for open bus ticketing is a challenge, and that doesn't necessarily need to be techno-like mandating a certain technology or specification, but certainly, the revenue split share agreements.** We don't need every detail of it. Or it's almost like a generic term, right? We've got, let's say 95% of them and then we fill in the specific percentage that we're going to give you or charge you for the platform, you know?

JG 56:45: So, what I understand and what I hear from other industries should be a basic regulation. It shouldn't be too detailed because if you overregulate, that would have, at least even maybe more challenges involved. But it should be a basic regulation, that should be there. Yeah, and I think that's very important. And the last question for you today. I hope it's okay with five minutes over time (yeah sure). So, the last question would now be regarding your view of the future. So, I've brought back that artefact again. But maybe you can speak a bit about your vision. Maybe for (city), maybe for other cities. So maybe imagine a perfect solution. What should that look like from your perspective?

I15 57:35: A lot of people talk about it particularly. What's his name? Hampo? (full name). The all-in MaaS subscription like Netflix will be so convenient for people to you know, pay one single payment, and get all their transport needs. And I get that it would be interesting in an urban area. B**ut for anyone who's kind of outside of a city, they're the ones who use cars, right? Anyone in the suburbs they're not a hardcore transport user every day. So, for those people like me, I live in a town outside of (city); I wouldn't pay for an all-in subscription because I can't make every journey on transport. I can use public transport for maybe 10% of my journeys at most.** So, I would never commit to an all-in subscription. I'm the one who relies on a car, and I'm the one that we need to attract out of that car. So, the subscription isn't the answer. I think that the subscription would be good in the city, but someone's got to take that risk, and there will be people who win and lose. As you know, effectively, you've got a seed fund for a lot of journeys and acquire customers in the way that Uber has and then try and make it profitable, a way that e-scooter companies have been doing as well. And some have found themselves not being able to make money because they spent too much on customer acquisition. So yeah, I think the commercial model still needs to be worked out for the value of an all-in mobility subscription. I'm not fully convinced it's going to achieve the business goals or even the modal shift goals personally. **But I think the real future with the potential of MaaS is the ability to gather insights into customer demand.** I'm really interested to learn where people are searching for journeys. What did they then choose to do so, and which options did they discard and go; that's not of interest to me. **And where did they just not travel because they couldn't find the option for them?** So, once we understand that **potential demand, we know where the gaps are in the transport market, and then we can look at orchestrating the transport network.** So, designing the routes, designing the new service frequencies designing the new fare products, we know which ones people are buying or not when they're presented with them. So **really getting that deep understanding of customer demand so we can design the network, the fares, the service to meet those needs.** So, and then also looking not only at what the customer did within the app but also at the journey they actually took. So, what time did they leave the house? What time did they get that train? Because you could buy a day ticket covering lots and lots of journeys, you don't necessarily know how much they used it and from place to place. So really **understanding all the movement flow and then bringing that back into the design of the transport network.** And not just the design, but there may also be some operational decisions. As we know, a lot of people want to move from there to there today. **Maybe because there's a special event on that we hadn't thought about. Let's redistribute and bring another bus from over there. And it's; h**ow do we have adaptive transport networks that can respond in real-time to needs? Because a lot of things are on fixed schedules, a fixed number of buses. It's hard to read the distributed things, but perhaps with shared mobility and certainly with autonomy in future. If you've **got a fleet of autonomous DRT vehicles responding in real-time to customers, shift them from one side of the city to the other because you know that huge demand flows there.** I think that the real potential of a **perfect MaaS solution for me is one that provides mobility as a service to the region and to the city, not necessarily to the individual**. What it's seen as a service to the city. I just made that up now. So, you know that I might refine that thought in terms, but it's who's the service to like as mobility as a service? That's it. I'm going to put that on LinkedIn later. It's going to get loads of responses.

JG 1:01:52: Yeah, no, it's great. I really like that perspective. I also agree that it will be a tool for the cities, maybe to control mobility to incentivise different forms of mobility to advertise different forms of mobility. Maybe it could also be a way to penalise some forms of mobility in future. But let's see. **But I think it will be mainly a tool for cities for authorities to control the behaviour.** Of course, for the user, it will also get easier. And I see the daily users in a city who can consume it in an easy way, integrated with their let's say monthly fares they pay. **But also, for tourists, if you're coming to the city, you don't know anything about what are the operations there? What are my mobility options there? So, you have then an easy way, and you can control them from a city. You can advertise for tourists, different things and so on.** So, I see it as a big platform or a platform, maybe in a region that is then expanding and maybe roaming to other cities, other areas. Yeah, so this is what I see.

I15 1:02:58: But I see, and that's my perfect view of MaaS, b**ut I can see some commercial players coming into the space as pure aggregators, like Free Now who's been advertising on TV in the UK.** They don't really have many options in the platform in the UK today, but it won't take long for them to add rail ticketing. And yeah, it may be that MaaS cannot succeed in a city because there are some good; I don't want to call them MaaS platforms, but let's call them mobility integrators or mobility aggregators. There are some good platforms out there, like Free Now. And maybe they just hoover all the market. And so, there isn't a role for MaaS, and so we don't get those deep demand insights. Therefore, we can't design better transport networks, and MaaS totally fails.

JG 1:03:50: Yeah, I mean, but if the city has the authority about that, so they can decide, they can control it. And they can say when you want to join the city; you want to be part of our mobility system here, then you must open the APIs. You must share the information. You must follow the rules set by the city.

I15 1:04:09: Yeah, but we can't make the customers follow the rules set by the city, and the customers may choose to use Free Now or Google.

JG 1:04:18: Okay, got it. But that's more than a paradigm shift, a mind shift that needs to happen, then inside of the people's heads towards more sustainability. But of course, I mean if it's comfortable, if it's easy to use, people always tend to use the things which are comfortable and easy to use, and I think that it needs to be in the future. Yes, all right. So, (name of interviewee), thank you so much for your interview.

Example 3: Interview between Julian Gebhart as JG and I2 (Interviewee)

The interview was conducted in German and has been translated into English.

JG 00:00: Hello (name) thank you very much for taking the time today to talk to me about the (case) Pilot Initiative, which was successfully completed earlier this year. Maybe you can introduce yourself again and describe your role within the (case) initiative.

I2 00:23: I'm happy to do that. My name is (name), I was at (case), one of the partners, as a project manager. I was there in the company development, was a core team of this (case) project. It was disputed by four transport companies - the (company), the (company), the (company) and (company). Everyone sent people to the core team, and I was the (case) representative in the core team. Of course, I coordinated all the work within (case), in case there was any company-specific work. The scope of this work was about twenty percent, that is, over the two years I was involved with the (case) for one day. (company) would have had significantly more resources in it, but maybe we'll get to that later. What was my role at (case)? (company) interests, the things that the transport companies do themselves had to and were allowed to coordinate communication measures, organize testing in (case), because certain different means of transport have been integrated there than other cities. That was kind of my job in (case) for (company).

JG 01:38: Yes, very exciting, also a very great initiative and of course I would be interested in a bit as a transition to the next question, how do you define MaaS and then maybe the ecosystem to it?

I2 01:59: In our (case): MaaS is the simplest possible and hurdle-free use of different means of transport in order to shape one's private mobility or professional mobility. That can be connected to the app, in today's world it's probably mostly connected to an app, but it doesn't have to. Therefore, a relatively simple approach to what MaaS is. It can be about routing, it can be about reservations, it can be about paying, or all of the above. I wouldn't put these different components as characteristic of MaaS just yet. At (case), we have focused on testing subscriptions, i.e. bundling different means of transport and offering them to people at a fixed monthly price. Maybe we'll find out afterwards what the subscriptions looked like or what the construct of the subscriptions was. We also offered pay-as-you-move and pay-per-use to book the means of transport individually via the app. The focus was very important for us on the urban target group, the urban population. Perhaps also back to the history: (company) drove the project. (company) is the largest Swiss transport company and about eight years ago it had, I guess, a pilot, which is now also a product. This is called (case), where they had also bundled various means of transport. Especially cars, electric cars and (case). This corresponds to the BahnCard One Hundred, i.e. one hundred percent rail travel possible and certain other services. There, however, the target group was residents in the vicinity of the cities, in the agglomeration, as we say in Switzerland. This means that a user of the (city) subscription drives his electric car twenty/thirty kilometers to the train station, drives to a municipal train station. He can also park there and continue by train from there. That was the model back then, it was very successful and has been a fixed product for years now. Only it is not a product for urban dwellers, because they do not drive from the city by car to the train station. The city is far too overloaded with cars for that, but they should take public transport and other means of transport. The idea resulted in this MaaS concept or the MaaS idea for (region), i.e. for the urban target group.

JG 04:37: Yes, it's also very exciting to see that a larger initiative started with this (case) and then grew. What were the trigger points or what made you say, let's say now, to say, okay now we need something new or now we need something for the city population? Was it more of a sustainability aspect, part of the mobility turnaround, that things drove it, or were there other factors that something innovative had to be found, or what were the motivations for bringing (case) to life?

I2 05:11: I think the motivations were different for all four transport companies involved. What united us: We believe in MaaS, whether it comes next year or in ten years, we believe in the potential of MaaS. Not at all to earn money, but as a control instrument for mobility in cities and agglomerations. MaaS has a tax impact from our perspective. What were (company) interests: (company) is the largest national player. Of course, they want to roll out MaaS throughout Switzerland and find their roles in there. They are strong in long-distance transport, but less strong in the last mile. Our interest at (city) was to try things out, to test. It was clear that MaaS would come in some form. We have very limited financial resources, so we'll get to that later. We looked, especially my boss: What initiative is there in Switzerland, where can we attach, because it was clear that it would hardly be feasible for (city) alone or for the city or for (city). So, we found out at the time which pilots or projects could be exciting. To be honest, however, the (company) approached us. (company) has made the concept, has already done market research and they had already engaged (city), or signed (company) with a tender as a SaaS provider. They then approached cities because they said, this is an urban project, I need the cities or the municipal transport companies, and have scoured the big ten cities in Switzerland to see who is interested. These were also the cities of western Switzerland, especially (city) and (city), and I think (city) and (city) as well. So, the bigger cities, they're not that big in Switzerland. Nine months have passed from the first meeting to the conclusion of the contract. So, I think in April 2019 we were asked by the (company), also the people of (city) and (city) and others. These four signed a memorandum of association at the end of 2019. In the case of the (city), i.e., the (company), the (company), which is integrated into the strong network, (region) is the largest and strongest network in Switzerland. They belong to the city; they are really a department of the city of (city) and there it was clear that MaaS would be extremely important in (city) in order to shape mobility. They have a second attempt, which is still ongoing, (case) is a second MaaS attempt and therefore they were one hundred percent politically covered there. According to the motto, try it out! For us, in particular, the deep integration, i.e. the level 3 integration of the MSP. (company) had undergone a great deal of change, in terms of personnel and organisation. Of course, they are on the move, especially in the border triangle. Across the board with Germany and France, they have a lot of commuters to (city) from France and from Germany, where the public transport subscription is sometimes cross-border, but also sometimes difficult, and they also wanted to test and try it out. So, the motivation was to actually try it out, of course to strengthen public transport. This was also an important question for public transport companies: Do the people who use

MaaS drive more or less public transport? Because today we are paid through the beginners. We don't get any money if you offer the customer a better solution, like (company), i.e., a better one for them if they don't use public transport. Of course, to increase the modal split, which is already gigantic in the city of (city) compared to other cities. So, we have a modal split, I don't know the exact number, but I think over 25 percent in the city of (city) next to public transport. We all have left-green cities, so the city governments are all left-green. They all want to get cars out of the city and promote pedestrians, non-motorized traffic, and public transport. In this context, we simply wanted to see what the customer wants, what kind of demand exists.

JG 09:29: Yes, the approach is also very exciting, and I find one point you mentioned the most exciting. It was not so much the money interests, but more because you were and are convinced of the concept of MaaS. This leads me to the next question. Now there are many actuators in such a system, you would have to analyse them all, let's say, and then decide who to integrate, who not to integrate. I would be interested to know what your thoughts were behind it. How were you able to convince the various players or then: how did you analyse them?

I2 10:04: Yes, of course, (company) made the first consideration, because at the time they contacted us, they had certainly already invested half a year of time and done a lot of market research. They had already looked around for a SaaS provider and had already signed the contract. This is of course one of the most important players, who provides the platform, that was and became (company). Then they thought: who do we need to create a subscription model for the cities, and there they came to the conclusion: First of all, I need the urban transport providers, it will be difficult for the public transport providers. That is why they are not approaching the cities, i.e., as a political entity, but the transport companies. However, not all of them either. I think there are five transport companies operating in the city of (city). We are the local that offers buses and trams, then there are also suburban trains, partly S-Bahn operators. But they approached the municipal transport companies and said, what other means of transport do we want to have with us, and these are usually the MSPs with shared services, these are the scooter providers (e-scooters), these are bike providers, but they also had taxis in mind. (company) CarSharing is the big player, I think it has been for 30 years, with shared cars, i.e., cars and transport bikes. So, they made an overview of what kind of means of transport would be possible at all, then checked it out via market research before the project started: What would you like to have with you? This is how they came up with the construct: we want to bundle the four transport companies, the municipal and (company) as a national transport company, into a simple company. There, the construct of the simple society was to draw up a contract. On the one hand, the contribution of these four partners was a cash contribution, i.e., they all pledged a project contribution, which amounted to tens of thousands of francs, and made resources, i.e., personnel resources, available. This was fixed and (company) had made the largest cash contribution and the largest personnel contribution. It was clear that a public transport subscription would be mandatory. That was part of the preliminary talks. For all customers who wanted to use (case), a public transport subscription was mandatory, i.e., a monthly public transport ticket, annual pass, whether local or in a network or nationally. This also **made it clear that public transport would not cross-subsidise public transport fares**. We will not be able to offer other tariffs for new customers, for example, if someone says, for example: I don't have a subscription yet, but I'd like to have one. It wasn't possible, from a regulatory point of view, to say: You get that for twenty percent less. As a result, the core was the four transport companies. The other mobility service providers had a different embedding construct. We had concluded two contracts with them through (city) as a branch office, two types of contracts. I'll get to it, which ones we then asked for and chose. Once upon a time there was an LOI (Letter of Intent) that says, yes, we want and we want to support them and we will also communicate together, and so on. And then there was a commercial contract or a commercial part, where the tariffs and the compensatory payments were determined. This is because the MSPs did not make a cash contribution to participate in the project, but a discount on their tariffs, however they were designed. The scooter providers have waived the digestion fee. They're quite high here at one franc, so before I drive a second or a meter, I pay one franc. That's one euro now, so almost one-to-one. They have enacted it and they have given us certain discounts on the kilometre or hour or minute tariffs. That was their financial contribution, or their ticket, and that was of course regulated in a contract between (company) as the branch and the providers. We **were limited, via the framework agreement with (company)**, i.e., the SaaS provider, to eight MSPs that we were allowed to connect in the financial package. So, eight of them were included in the contract and then it was simply a big problem, which MSP are there in the three cities, how are they technically ready, or are they willing to participate. So, it wasn't like you had fifty to choose from, and then somehow selected them down to eight with certain criteria, but we were happy to get some at all. Especially in (city), we were able to start very late. We started much later because there was no scooter provider yet. We had integrated Voi and Tier everywhere, but Voi and Tier were not yet in place in (city). The city of (city) didn't want uncontrolled growth, they didn't put it out to tender, but they did get a permit. This was extremely restrictive, with a certain number of scooters, with an exclusion zone in the old town, i.e., where they were allowed to be parked, and also limited to two providers. We had Bond in (city) as a provider, but they are now insolvent. But they withdrew from (city) before the project began, so we didn't have a bike provider in (city). The top dog in these cities in Switzerland is (city), which was actually founded by (company). We had had intensive discussions with (company). They **weren't technically ready and weren't willing to invest in the pilot, but that's perhaps a separate issue**. Mobility is the car provider. They have two characteristics: they have (company), which is free-floating and similar tariffs as the scooter providers, so they could be integrated very quickly in (city). The other is (company), which is station-based and stupidly, I'll get to the subscriptions later, stupidly **they don't transmit the data, the reservation and usage data, live**. In other words, we wanted to offer subscriptions, we also offered subscriptions. Our desired subscription was a minute package, i.e. specifically in (city) thirty minutes per month you bought for ten francs and could use the thirty minutes for all connected means of transport. You could use the whole thirty minutes for one scooter provider or for the other scooter provider or mixed. **For this, of course, we needed real-time data of usage. I can't do a minute package if I don't have the real-time data.** This was not possible with (company), because they did not transmit the usage until the next reservation and if there were four days in between, you might have driven it empty. But we are still talking about the ecosystem and the actors. We had tied one up at the very beginning, Lime, which was then no longer in the market, so purely given away, so we couldn't use it. And then there was also one, (company), which is the bike provider in (city), which we later integrated with an extra amount. So, we had already exhausted eight providers later, so we as a project partner had to be willing to pay an amount to (company) to connect (company). The most important other player was (company), i.e., the university, for research support. The research support was very important to us, they were already part of (case) at (company) earlier, they asked research questions, they also searched for and interviewed the control group. We wanted to find out the influence of the (case) subscription. In other words, they gave us extremely strong support in terms of research, and that was the next important player. So, there was a quasi-four-tone. (company) as SaaS provider, the four transport operators, the MSPs as asset provider and (company) as research partner.

JG 18:51: Yes, very exciting, so especially what you said, or what I heard, is on the one hand the challenge of finding the providers at all, because there weren't that many in (case name) now, or that there was volatility there - providers were suddenly there, then they were insolvent, then maybe an interface has changed. Maybe you can describe that again.

I2 19:16: Yes, of course. So, we had a lot of conversations. First of all, the market is dynamic, so on the one hand the appearance of players, but also the disappearance of players. Bond no longer exists. In (city), we had integrated them, but a month before the end they went bankrupt. **Some other players on the market are not technically ready**, such as (company). (company) is a station-based bike rental system, which is extremely prominent. The city of (city) had put it out to tender and I think they have three thousand bicycles. I also use them eagerly. The first thing to do is to open the lock with Bluetooth. For one thing, (company) didn't really want to support this technology. Secondly, they had a pricing system that would have made it extremely difficult to integrate these minute bundles, because of course the tariffs have to be similar or comparable somewhere. The third was that **they would have had to change their entire backend to be able to map this live data, the deep integration, the booking**. And that was important to us, we actually want to be able to reserve all means of transport via the app. Display not only the routing and the suggestions, but also the booking, opening and closing and payment. That means we opened and closed the scooters that were best integrated into our app. There were talks there for two years, (company) with (company), and then we took over. Personally, I said that we really have to clean up the mess now. It was clear that when you come together, you only come together on a manual or manual marketing level. Because, but I'm not firm enough, (company) and (company) have always said that there is an international standard of integration. Some MaaS paper, but I can't quote it now. And there we passed at level three. Voi and Tier have already had this. (company) and their software provider have said that they do not perceive this as an international standard, they are bombarded with requests, but they participate in the MaaS system in Switzerland and their statement was that if they invest in the connection to (case), a significant amount of several thousand francs, if they invest that, they would still have to spend (number of) francs on other MaaS projects, to adapt this, because **the standard for them is not yet such that they can invest once and then operate X MaaS systems with it**. There I'm wondering whether it's right or not, but that's where (case) failed, also because of the aspect: Hey, you only have one year left, three quarters of a year, we don't know what will happen next. It was a pilot who was limited from the beginning to the end of December 2021, that was the hurdle there. We had also asked taxi companies, often they were not technologically ready, but in (city) they would have been. But then they wanted a commission for every trip made via (case). Instead of saying we see this as a sales channel, we sponsor a bit, they wanted commissions instead. Then there's the issue of (company). (company) would have existed in (city), **but cooperation was politically extremely delicate**, in Switzerland the social court proceedings were underway with bogus self-employment, where they have to pay social security contributions, and politicians, we are all owned by the municipalities, said: As long as this has not been decided, please do not integrate (company), as it is politically sensitive. This means that we have always, or rather the (company) has held the talks, an incredible number of conversations to see if they are willing and able to participate at all.

JG 23:18: Yes, exciting, so now also the technical reasons, the one with the functions that the different functions had and then also some backends were not yet available, or let's say the interfaces were not yet available. I would also be interested, of course, they now also have an effort to integrate the MSPs, and you talked a bit about it. Is there an international, let's say, requirement? You also said that there is one, but still have these costs. Here I would be interested again, were there any other challenges? Did you have to leave out a few functions or did you say, okay, because we're just a pilot for now, we'll use a small range of functions for the time being and if that works well beyond the pilot, you'll expand it. Were there any considerations or something like that?

I2 24:14: So, there are two answers or two different responses from us to the question. The first one was perfectly clear, in the pilot you still do some things manually, which you would ideally have liked to have automated in operation. For example, what we did manually, even though it was promised otherwise despite the deep integration, was billing. So, from the basic construct it is like this, we have bought contingents, we as (case) have also borne risk, we have bought contingents and have sold (company) again to the customer and thus of course you have this trading risk. If all customers, all subscriptions had been utilised to 100%, we would probably still have done lousy. Since they didn't do that, so they took advantage of less, we made a plus. So, we have analysed everything, i.e. (company), where does the customer benefit, because he will pay more if he books individually than via (company) single journeys. Where does he benefit and so on. And there, of course, a settlement is needed. In other words, our office, which wasn't me either, but (company), billed the MSPs on a monthly basis to find out what was really being done via (case). The hammer was, actually it was the prerequisite that this could be automated. But it wasn't feasible. With everyone, even with Voi, Tier, who are otherwise very high-end moderately on the road, you could not bill for the trips. This means that **one of us at the office had to manually pull out all the trips via Excel and then invoice the MSPs**. That was an **unbelievable effort**, it wasn't a function for the customer, but a TODO, or task, where we did it manually. Of course, the whole support was completely different. The support was by mail and only during office hours. But the more exciting part was, with MSPs who didn't have all the features yet, we had designed other plans. We had several types of subscriptions. I said earlier that the standard subscription was a time-based subscription. I buy thirty or sixty minutes, we even had four hundred minutes in (city), that would have been a so-called full flat, i.e. four hundred per month, for one hundred and nineteen francs, but nobody bought that. With some, such subscriptions were not feasible. It wasn't feasible with (company) because we didn't have real-time data, so we introduced other types of bundles, called one-percent bundles. That is, we said you can buy a monthly bundle for nine francs, or nine francs ninety, where you get a fifty percent discount, on Mobility, which are the Mobility station-based cars, and (company), is a cargo bike that is also station-based. You get half the price on the time, i.e., the time tariff, and half the price on the kilometre tariff. Because it doesn't depend on the time of settlement, you just get it charged when they charge it, but you get a fifty percent discount. As a result, we have responded with other bundles there. And with Pay as You Move or Pay per Use, which we also offered, it didn't matter there anyway. We didn't have a parcel there; it was charged there when it was there. At (city), we tried to establish a semi-manual cooperation where they would have been willing, but then (company), our software provider, was not willing because that would have been at their expense, or at our project budget, so we were not willing to implement this semi-manual solution, because (company) also said: Hey, we're just integrating something at our expense, if we can also use it worldwide. And that's such an edge case, we're not willing to invest a five-figure sum for the kind of wish that came from (company). So, both parties have said that the upfront investments are actually too expensive for such a half-hearted solution.

JG 28:15: But of course, that's also an important point, that the data is available at all, and that's when you notice that these standardized interfaces, that everyone has their own data silos, everyone has their own solution. But the fact that they work together is a great deal of effort behind it, which I now understand from you as well.

I2 28:34: Right, because for example Voi and Tier were not able to store different prices for different B2B customers, we are more or less a B2B customer for them.

They were super super modern in the direction of the frontend and customer, but at the back, the B2B constellations: Aha, the partner, we give him ten percent discount, the other maybe twenty, they weren't able to cover the backend at the time. Maybe they are in the meantime.

JG 29:03: Okay, very exciting and was it the same, let's say with Uber? I mean, (company) is also trying to offer MaaS, so yes, Google Maps, they're trying to do that a little bit. Of course, this is still a completely different solution, but if you now integrate something like (company), of course you meant, there is such a political component that the city says, there is still this one critical law, but I could also imagine that there is a kind of competition then, between the platforms. Have you observed something like this in the form or less?

I2 29:37: At the beginning. So (company) and (company) less, for us it was mainly the (company) market entry. (company) had been wanting to come for five years, and they have now managed to enter the Swiss market via (city), i.e., via (city), the (company). There they have access to public transport ticketing. Because in Switzerland, every public transport company can sell the public transport tickets of all others. There is a central database, the Nova database. (company) cannot agree with that, that is currently being discussed. This is a legal situation in Switzerland, NADIM was called it, now it is called something else. Which providers are allowed to access which data and which they have to deliver, i.e., all modes of transport, not just public transport. Which is why, with (company), we always ask the question, yes (case), do we want this, or do we not want a nationwide solution, driven by (company). Well, (company) has now been commissioned by (company). **We had**

already noticed this competition in quotation marks, or these different facets. You don't want to take part in the fact that (company) has also been requested by many. That's where the topic is, of course, and that's quite opportune, so I mean, competition doesn't always hurt. There's just the manual effort, or the personnel effort behind integrating all the MSPs somewhere, plus the public transport companies, because Switzerland is federalist, so Germany is also federalist, but Switzerland is, in my opinion, 10 times more federalist. Everyone does it a little bit through their own way and (company) would also have to conclude all the contracts and technologies they would have to conclude with Voi and Tier and (company) and Mobility in addition to a public transport provider that they have. So, they can't get around that and that's why: Nobody will join exclusively, so Voi would not connect exclusively to a MaaS provider, but standardisation is needed there, at least nationally. So that you say, yes well, I'll plug in at (company) or in at (company) or whatever as an MSP to somehow add value to the sales talks there. But of course, it was clear that (company), as the Swiss transport company, was keen to see (case) continue to run beyond that date. Because building a platform, building the algorithms, making the connection, that's super time-consuming work. For us, it took two years, and they would have liked to continue running it, regardless of the function. Simply to keep their foot in the door so that they now have a product where they can design in one direction or the other. And then not surrender to (company) or other players, or Switzerland is then at the mercy of these players. I would have liked to have come to the customers, as actors, but I don't know if that's a separate topic.

JG 32:51: Yes, that would be another topic for later. Maybe we can stay with the regulations for a moment, perhaps. Did you also pay attention to aspects such as

GDPR? Was that a big issue? This is now also a bit in the direction of customers, because the customers disclose data, they log in, they use the services. Theoretically, you could create movement profiles of customers. That's why GDPR is a very important topic here. I would be interested to know if that played any role for you or did you rather ignore it?

I2 33:29: GDPR doesn't mean anything to me now, is that the European Data Protection Regulation?

JG 33:35: That's exactly what GDPR is.

I2 33:35: There were two facets. One is the data protection regulatory aspect, there were entire workshops between the parties before we even started and there it was clear that this had to be taken into account. Switzerland is not the EU, but Switzerland has taken it over, so this must also be taken into account. Then it was the case that an incredible amount of data was generated by the project, i.e. on the one hand via (company), but also via the (case) research project, so we were then told that it would have been the world's largest MaaS data set in a pilot project, because (company) had also collected a lot of data via questionnaires and so on. For example, the research customers also tracked them via their own tracking app, over all their traffic routes from (city), because you couldn't track the routes perfectly via (company). You could only track the opening and locking of the scooters, not public transport, we didn't have a check-in/check-out, you didn't know how they went by public transport. But (city), as a branch office, has generated a data dumb from all this data, which all three other transport companies would have had access to per se if they had been interested in exploiting it. (company) and (company) could not. **In other words, (company) and the people of (city) have neither the resources nor the know-how to be able to do anything with them.** The (city)-based (company) had that, they had a whole data analysis team and there, of course, it was also important in every company what data protection requirements they have, how do we do it procedurally with the deletion, because if a data dumb is available monthly or weekly, I don't know, pull it off and do with it evaluations and if the customer wishes to delete this data, all partners who access the data dumb must ensure that they are then also deleted in evaluations that may have been running half a year ago. These were the data protection experts, I was less involved, but that was then ensured through internal processes and agreements that the data protection directive was introduced. (company) has said that they have a stricter data protection requirement than the directive, i.e. (company) as internal governance, but I don't know the details, and because (company) hasn't deducted the data either, I'm not in any closer to it now. But **what was a bigger hurdle for us, or a bigger aspect, was the financing of the project**. There are also regulatory reasons for this (case). The Swiss public transport system, i.e., the four transport companies, is organised quite differently, as they say. (company) is allowed to make profits through long-distance transport. This means that (company) can make a profit through long-distance transport and through its real estate. That is, not in regional transport, but in long-distance transport. This means that (company) certainly has funds available from business activities that it can invest in innovation projects. A normal transport company like (company) is not allowed to do that. In Switzerland, we call this "Service-Püblic". We don't make a profit, we make losses. Our business, i.e., passengers driving around, does not cover costs. (company) has a very high cost recovery ratio of 75 percent in its core business. The rest pays, not the city, we belong to the city, but the canton of (city). **Switzerland has a different financing model per canton, and so far, innovation projects that are not necessarily related to the core business have not been financed by the public sector.** In other words, we could not say, yes, we have a budget of so and so many millions, then let's just take 200,000 now, but it is similar in (city) and (city), but we can still do today, and now this is changing, such innovation projects that are aimed at public transport but are not our core business, we can only finance it through the profits that are made in the free market. The free market is extremely limited, we hardly have a free market, for example, we do maintenance, i.e., bus maintenance for other bus companies. This is a free market, they put it out to tender. This means that we have hardly any money available to finance such projects. This also means that we had a Smart Shuttle, an autonomous bus, at (company). We can't finance it ourselves; we need sponsors, or we have to finance it from the profit that we have laboriously generated elsewhere. That is to say - why? There **must be no mixing of subsidised businesses with such innovation businesses**. This meant that I had to write down my hours extremely precisely, write down every hour that someone worked, and also pay for it via the special pot. That means, for example, a city of (city), the city of (city) belongs to us, but does not finance us. We are financed by the entire canton. They also order all the traffic; they say the line should run every five minutes. **The city of (city) is an actor that is also important, the political actors were not involved at the beginning of the project.** In other words, the (company) approached the municipal transport company and, depending on the situation, they may have informed their political arm of the owners or the purchaser that we would do it and they said, yes, yes is good. But that's also a very important learning for the future, and I think we'll get to it. **The city was not really a relevant player, i.e. (company) most likely, because the (company) belongs to the city there, but the canton of (city), (city), canton of (city) were only involved in a very rudimentary way via the information channel, which then turned out to be a serious disadvantage or an important learning.** This means that we did not receive any money from the city for the project, no money from the canton, but used it from our profits from other activities.

JG 39:43: Yes, very exciting, the topic of funding is of course immensely important, because MaaS is not primarily about making money, that should be clear to everyone, but about making something easier for customers and also about achieving a certain paradigm shift. A change of mindset (a change of mindset, exactly), from this own mobility to shared mobility, and I think that's important that it is then recognized and that it is then also financed. But were there any other regulations that were, let's say, initiated by Switzerland or the cantons? Or were they just, let's say, FYI involved, or did they then determine something and said: Hey, you're not allowed to do that in (city), for example, for such and such a reason. Were there any political influences in this form?

I2 40:40: Yes and no. So not directly on the (case) project, at (city) the data protection regulations were the only thing, and I mentioned the financing. But we didn't contribute any of our own assets as (company), we didn't operate any means of transport, the four transport companies of course their normal public transport, which was included, which means that we were dependent on MSPs and their assets, which were regulated completely differently depending on the city. So, there we had restrictions, but over two corners, over the MSPs, so to speak. (company), for example, is a free-floating car sharing service in (city). Free floating means that they are allowed to park it anywhere, at least in all designated parking zones. Even before us, this has nothing to do with (case). (company) is not allowed to be offered in (city) and (city) because the cities have said that we want a station-based system here, we don't want them to stand around everywhere, but to designated parking spaces. In (city), there are now eight scooter providers with thousands of scooters. They were there first, the city of (city) said: no, we want to limit it to two providers, with a maximum of 300 scooters in total, with geofencing, that they may not be parked in the old town. In addition, they had to be throttled to five kilometres per hour in the old town, all controlled by GPS. In other words, there were of course urban or local restrictions on our providers, i.e., the MSPs, about their business model.

JG 42:25: Yes, that is understandable and important.

I2 42:28: Otherwise, I wouldn't have been aware of any regulatory limits that I can think of right now.

JG 42:34: Okay. Maybe now again on the customer side. Were there any challenges in terms of acceptance, i.e., how your offer was received? Was it accepted directly and successfully? The project was also accompanied by (company), I understood (yes), who accompanied the project with their research. I would be interested to know - what were the challenges of getting the customers on board?

I2 43:00: You have to look at it in two parts. They had actually planned with (company) to accompany the research project in all three cities over the entire duration, that was the idea, but we had delays and had to go live in stages. First (city) and then (city) and then (city). The research project actually only ran for three months in (city). So, the evaluations took longer. This means that there was a preparatory month, a test month, and a follow-up month in (city). Together with (company), the (city) public transport company, (city) has been looking for pilot customers, i.e. not only for the (company) pilot, but also for research customers, and they have been looking for an advisory group. There were a few hundred people each who were targeted. We had to incentivise the support group from the population that had zero to do with (company) and the research group. In other words, (company) has incentivised them, which means that without money, they won't participate in something like this. I think there were thirty francs a month. The research customers who have committed themselves to buy and use (case) for one month and also to use the additional tracking app during that month, where really all the paths have been recorded. They were interviewed intensively before they bought and used (case) and afterwards. The control group was also interviewed beforehand and interviewed afterwards. He was very successful, the pilot. (company) was able to derive very good results from this, in (city) and (city) and then in (city). (case) was still going on, so we as a project team evaluated certain things. What is there to say about the customer? The focus was on B2C, i.e., the private end customer, i.e. the urban target group. The demand for the subscriptions was ten times lower than we had hoped for the pilot. The **demand for subscriptions was very disappointing**. I can't give you any numbers right now, but it was very disappointing. It turned out in the end that the number of trips made via (case) were almost more pay per use than via the subscription. **This means that a subscription, which was also a learning with us, is difficult in the MaaS context, or not promising for the next 10 years.** Because we were fully in the Covid period, we started in lockdown, or shortly after the lockdown, where they called on everyone to stay at home, that distorted our result, but not in such a way that we say it explained everything. In Switzerland, many of our target group, the urban target group, already have subscriptions. They have their mobility (inaudible). In other words, in Switzerland, many people have already organised their mobility via subscriptions. A lot of people have a transport association subscription, a lot of them have a (city) subscription, I also have a (city) annual subscription, a lot of them are cooperative members of Mobility Carsharing, so they have a subscription there. This means that all the important ones, i.e., not with (company), they probably don't exist yet with the scooters, but the Swiss have already organized themselves with subscriptions. So why another subscription or if subscription, then somehow creditable and then you almost go crazy in the backend with the crediting of certain things.

JG 46:38: But maybe that's also a lesson, that it's the combination that might make the difference. And maybe you also have to differentiate between the people who live permanently in the city and actually already know most of it and those who are now perhaps there as tourists and now just know or would like to find out the best way to get from A to B (yes).

I2 47:03: Correct and a point of criticism was also that the public transport subscription was a prerequisite. **Of course, that was a big hurdle, I have to take an expensive one in the monthly subscription, so even for a tourist who doesn't take a public transport subscription, that's also a lesson that the public transport share should actually be able to be booked modularly.** Well, in the end you can say a monthly subscription of thirty francs with shared transport, then you add another seventy francs for a monthly subscription, **but it was also technically very difficult to book a monthly public transport subscription via the app**. So, we, as drivers, were actually technically and politically not necessarily willing to support this. This means the full integration of individual journeys or individual components. But what possibly, in our pilot we were approached a lot by companies. This means that the **B2B part, which we actually found almost more exciting after the year of pilot operation**, and where we have considered, we will not continue the pilot in the B2B sector. For example, I used to work at (company), and I used to work in travel management. (company) is the equivalent of (company), has thirty thousand employees at fifteen locations throughout Switzerland and they said: Hey, with Covid the GA is no longer worthwhile. The GA Travelcard is the BahnCard 100, which has been very popular because with two days in the home office, you no longer need a GA Travelcard. It's not worth it anymore. We need a nationwide offer where you can take different means of transport, such as (case), modularly for our employees. The same applies to the chemical companies in (city), which have many commuters, as well as (city). In other words, large companies that say we want to offer our employees a flexible, modular offer. With their own assets, i.e., they may have their own pool vehicles, or with assets from third parties. These were exciting questions, but we didn't pursue them further because that wasn't our focus and because of course it was over, I used to make it in the B2B sector in mobility, where standardisation is also incredibly difficult, because every company wants something different. In other words, there were exciting questions there in B2B: Hey, that's cool, that's what we want, don't you have that for us too.

JG 49:27: Very exciting. I mean, once you've launched it and it works, then you have a certain critical amount on your platform on board and then, of course, it's also interesting for a lot of other areas, now not only for the customers, but also for the logistics industry, but also in B2B, what you had just said, i.e. that other companies now want to book mobility packages for their employees or something similar (yes, exactly). So, I can imagine that this is really a basis for having such a mobility platform and that many other things will be made possible from it that are not yet possible (yes, exactly). Yes, I'll go a little further to the next question (yes). At B1 we have now talked about all the actors, and we have already touched on a lot of things somehow in the interview, but maybe you can briefly summarize again how you got in touch with new actors and what the challenges were again, maybe in a few short sentences.

I2 50:37: Yes, so first of all, the whole partner management was the responsibility of the (company), the office. So (company) was initiated as an office, which means that all the actor maintenance, except for the political MSPs, was in the hands of (company). (case) has attracted quite a lot of attention in small Switzerland, and unfortunately not among customers, but among experts. In other words, we were approached many times and the players in the three cities were well known. This means, for example, the taxi companies, which are known in the three cities, the scooter providers, the bike providers. This means that there was a manageable number of players who were contacted directly by (company). If you were interested, **it was followed by an LOI and then with the appendix with the commercial conditions that existed when you really got together**. This then included the areas, the tariffs, the prices and more. Of course, you also have to support the connected MSPs, and of course you also had regular contact with the MSPs in support, because if they had a problem, i.e., the customer with the vehicle from the MSP, but with (company) they have a subscription, then they approached us. That is, there was definitely a contact with them in support. We've **had fraud cases quite significant, which were then often done through an MSP**. There was the question, do we have to collect it now, because we owed it if someone misused to borrow a car, then we were charged for it and we had to collect it from the customer. So, of course, you have to discuss the cases with the affiliated MSPs, what do we have to pay, how do we pursue this, do we block them and so on. This is, I would say, a special case, i.e. fraud. At some point, we were a bit limited with new ones, we only had eight in the contract with (company), so to speak, we couldn't integrate hundreds more. But there weren't hundreds on the road either, so (company) was the most important, we informed the rider three quarters of a year before the end of the ride, no, nothing more will happen. So, from that point of view, these were all direct contacts, bilateral contacts via calls, trying to integrate the newcomers. But it was all going on before the pilot, because all the discussions went on for a year or a year and a half until a player was live.

JG 53:16: Yes, of course, that's logical and clear, then you had to convince them first and then you had to integrate them, you said earlier, there were different levels of such an integration (exactly). Among other things, deep integration. Maybe you can summarise that briefly.

I2 53:34: The goal of us, i.e. (case) and (city), was to establish a so-called Level 3 integration. This Level 3 integration is defined in a standard. That means, ideally, the booking, the payment, i.e., the payment anyway, a (company) subscription is solved, also the reservation everything via the (case) app, so no jump, that was the basic philosophy. There, the different players had different requirements, the new ones i.e., Bond, Voi, Tier, i.e. the scooter providers, they fulfilled almost all the requirements per se. They have probably been on the market longer, the fewer, they have fulfilled it less and then you had to see how you could still integrate them. But the challenge of the integration was that we wanted to integrate it into a subscription and (case), our software partner, didn't have any subscriptions until then. This means that the entire functionality, integration in a subscription network, had to be reprogrammed by (company) and, depending on the MSP, also depending on the subscription type, minute or percent subscription, this was development work. That is, they had a lead time, as far as I know, I had no contact with (company), of six to eight weeks, until an MSP was integrated into a subscription. That was the lead time there, then of course we had to test it, also a lot of routing stuff. The routings, i.e., the public transport information, are available in published form, but are not always completely correct. That means we had to test the routing, test the location, we had to test before we went live, do they work, can you open and lock the scooters, we had to test that. That went relatively well, and we went live and of course over time, we had another MSP integrated in the course of the project. It's (company) from (country). But in the course of the project, we launched various other subscriptions that also had to be programmed. For example, we had a 24-hour flat rate subscription. We launched it in the middle of it because we realised that it could be a customer request. We also had trial subscriptions because, as always with new products, which is a new brand, even new products with scooters and a completely new type of mobility offer were tested free of charge in (city). Then we launched a 15-minute free subscription, so to speak, also to get people up to it in the first place. Unfortunately, not too many of them were then converted into a paid subscription, so the functionality, the integration of the MSPs, was one thing, that was certainly work, (company) already had a lot of experience there for pay-per-use. The subscription integration and new subscriptions were then more of a challenge or focus for us during the pilot period.

JG 56:46: Exciting! Perhaps here is another question: there must have been many challenges, we have talked about many. From your point of view, perhaps from a political point of view, what was the biggest challenge for you and how did you solve it or how did you approach it if you couldn't solve it?

I2 57:11: Yes, so for me, maybe again briefly the topic of the market, so the demand was a huge challenge, the demand was far too low. How did we address them? We had to take note, but the learning was that a new product, i.e., a MaaS subscription, a new brand takes time, a year of pilot is far too short. This takes three to four years, especially if you then want to change the modal split from the car owner. But a pilot of three to four years was not financially feasible for us, so we had considered extending it for a year, but that would probably have cost over a million for everything together, i.e., software, marketing and personnel for the four partners. That was not feasible, so demand was the biggest hurdle, but we reacted to it with the promotions and advertising measures, also advertised all the TUs up in the vehicles, but the demand was actually one of the two biggest hurdles in retrospect. The other obstacle was the **political landscape, or rather the political background**. A business model, commercial, that the platform providers or we earn money now, was a utopia, so it's not utopian in 10 to 20 years, but that wasn't in the foreground in the pilot. Rather, the control of mobility, or the relocation of mobility, is politically desired. There is the core, we as municipal transport companies are contractors, we have the order from the customer to design the public transport as he wants, as it makes sense. And the city or, from my point of view, a conurbation, not only changes (city), but we also have municipalities here that have grown together with (city), the conurbation actually has an interest in shaping mobility the way it wants, the way it wants politically, the way the voters want it. **That means reducing car traffic in the city of (city), perhaps pushing the scooters and so on. But it is precisely this actual urban transport policy or mobility strategy that (city) does not have in the form of a large number of players**. (city) has one, we don't have it. They also don't have any specifications, such as how the mobility players have to interact, the permit for scooters, but there are no requirements for them to share their data with public transport, for example. In other words, the design of the bundles, the offers, the MaaS offer, must actually fit together with a mobility strategy of the city. Because we have had a lot of ideas that we could now make a special offer here for B2C or another B2B here, using means of transport that go beyond public transport. But does this now correspond to the will of the city, that was unclear at the beginning, including the financing. Because a city has a mobility philosophy, a mobility strategy, and also has the money available to control it: abolishing parking spaces, traffic calming measures, other traffic light controls, they have such a budget. **The biggest hurdle is actually that, or even the learning, that MaaS is actually an important tool in the toolbox of the city or the public sector to shape traffic the way they want it.** You can react very flexibly with a MaaS system by adjusting prices, if an example is a trade fair, or a football match you can control the traffic. The biggest hurdle was that the cities, the three cities were not on board, and as a result we A, after a year simply had no more financing, we three urban transport companies, we had B, did not know, yes in which direction does the city want to develop, does it see the focus more on B2B or B2C, they want more taxis, this and that. That is, that was the hurdle why, i.e., the pilot was not aborted, but was regularly terminated or not extended. As a municipal transport company, we have learned a great deal. We have had very good discussions with the cities with the (case) pilot, I also get to it, what happens now, I still get a little bit. This **means that with the (case) evidence, we were able to have completely different conversations with the cities than before only on the basis of PowerPoint slides.** We went there and said, look here: Ah yes, this will be going on for the next ten years. Yes no, look here - so you **could really enter into a dialogue with the cities** and tackled it on two tracks. We let (case) expire because we said we lacked the political background and at the same time, the three cities, (city), (city), (city), welded together. (city) is a different construct, it belongs to the federal government, they have no anchoring with the cities. The three cities, the transport companies and the executive, i.e., the politicians, the decisive politicians, have been working together for a year to get an idea of MaaS. **In other words, they are planning a common or coordinated MaaS policy, the three cities.** The transport companies are on board, what role should the transport companies play, i.e. public transport? Should these be the aggregators, should they only be providers? And there, according to my latest status, they want to jointly design a MaaS platform, i.e., the three cities. The technical aspects will be put on the side for the time being, and we don't know whether (company) or (company) will come back into play. But the three largest cities in German-speaking Switzerland say we want to act together politically and in terms of public transport and use a common philosophy. But that takes epic time, I mean the political discussions among the transport companies, epic time, the learning was, they weren't on board, they learned a lot themselves. **Through the pilot, we got them, or forced them to think about a mobility strategy for the city or for the conurbation.** Providing funds is not exactly easy either. This means that (case) has **achieved an incredible amount in the minds and in the political framework conditions** in the three cities, which can lead to the next MaaS construct being designed quite differently and also covering something completely. Integrated by the city with the players, who were perhaps not integrated as MSPs, but really a holistic solution. But this takes time and money and **also the will of the cities to invest there, i.e., human resources but also financial resources**. In other words, we have tackled it by holding intensive talks with (city) with the city, which would not have been possible without (case), and this now results in political processes also with the transport companies involved, which put the whole thing on a clean foundation so that a MaaS system can also develop the control effect that it is supposed to have, at least in our country, because a business case is difficult.

JG 1:04:31: Yes, exactly, I see it the same way. A business case is difficult, but what I have now also understood is to create this awareness in order to then make the cities and the decision-makers, then also in the cities, aware of what MaaS is and what you can achieve with it, and I think you have created that with (case).

I2 1:04:50: Yes, of course, and then also an exchange among the three cities, the politicians, i.e., the executive, i.e., also the transport ministers of the three cities, they have never talked to each other about the topic. In other words, we have also managed to do that, including that they talk to each other and talk to their transport companies. This is a super successful pilot, not in the direction of customer demand, but for us an incredible success that we have created this awareness and are convinced that in two to three years it will be rolled out and accepted in a completely different way than it is now by our pilot.

JG 1:05:28: Super exciting and we're already a bit into the second question (yes). Exactly these external measures, what you had hoped for, I have already heard. Of course, you had to update them first and say - look, that's possible today and you can do it today. But then, of course, it might have been better if they had said: Hey, Mobility as a Service, we have a technology scouting team, we've had that on our radar for a long time. Here we now have a find of, what do I know, ten million Swiss francs for the cities of (city), (city) and (city) and do something with it and try to actively drive it. Because a business case for now, it's not there.

I2 1:06:22: **Exactly, so what do you want on paper, what do you want to control, what do you want to achieve with MaaS. Secondly, how do we finance the MaaS together with the cities and thirdly, of course, very important, especially**

the topic of data or software integration. The city actually approves a lot of players or has a thumbs up on a lot of players and has to determine there: With every tender, with every approval, the MSP is obliged, and is part of the tender, to ensure the exchange of data. From my point of view, Level 3 or Standard X, with the public transport companies, i.e., when public transport is the aggregator. Because then a sharing entrepreneur knows: Hey, I have to have certain data, certain interfaces available here and can price it in before then, because now it's like this: You always come here afterwards, they got the contract and now you're still coming, I didn't even take that into account in my calculation. In other words, to adapt the urban framework conditions, or to adapt the framework conditions by the city, for approval of **other means of transport in the city, so that this ecosystem also functions in terms of interfaces.** That's the third component in it. They've already done that, they've already done that during the pilot. Those who then put the new permits out to tender included a new passage in the tender documents for data exchange, but of course this is not yet perfect and has not yet been coordinated with the three cities. Because (city), (city) and (city) should also work together if they have and operate a common MaaS platform at some point.

JG 1:07:59: Yes, these are super important points and I think these are also very relevant insights into, let's say, this early phase of MaaS, which we are unfortunately still in. Last but not least, and we're a bit over time, and I hope that's okay with you (yes, never mind, it's good). Exactly, with the last question you can go a little crazy, now we have presented the problems in the present, what the challenges were, also perhaps how it should be in the near future. Now I would like to see what such a future solution should look like for a city, or perhaps more broadly for a region, for a country or maybe even globally.

I2 1:08:55: There are two aspects to that. On the one hand, what does the customer want or what would we want from the customer's point of view and what do I need for it. From the customer's point of view, of course, it would be necessary, as we philosophised about that right from the start. From the customer's point of view, it would be extremely exciting to be able to put together all relevant modes of transport in a modular manner. That was the subscription idea, it can also be routing, it can be a single booking, it can be some added value. For me, this means, and here we come back to the app, as **a meta app, across all modes of transport, that I don't have to open eight scooter providers that are still free-floating to look**: It's just around my door right now. I already experienced this eight years ago in Berlin, with the free-floating car and electric car projects. They all had their own app, there was a Meta app and you could see where they were. In other words, all relevant means of transport are displayed on an app, a platform, ideally it is also possible to reserve and book. So only make a reservation when you need to reserve it, or book and pay with an added value that perhaps goes beyond the mere display of an app. This can be routing, that he suggests exciting routes to me, perhaps in rainy weather: not the cheapest and not the fastest, but the driest. Or even the safest: I don't want to change quarters at night via a problem, because otherwise I might be attacked. That is, these are points from a customer's point of view. I'm not sure about the subscription, so of course that would also be a wish, but if I say: Hey, I'll spend 500 francs per month now and then I won't have 30 free minutes, but all the ones I need and put them together. I'm not sure if that's a real customer request. Well, according to the survey, yes, because you already organise yourself with your means of transport. But the subscription is priority 2. Pay-Per-Use has to query as many routings as possible in one app, sustainably, quickly, efficiently, securely and dryly. That would be such a wish, I don't know if that's feasible. Modularly composable, that would be a bit of a topic. Now comes the other side, the provider or the political side is, how do I want to control that. **I think this is needed locally. Globally there needs to be a standard, globally for me there needs to be a data exchange standard of a technical nature. But every municipality, every municipality, every country has a different type of transport policy or mobility goals.** Whether these are conservatively governed or left-green governs plays a role or what the conditions are. **In (city) we have a UNESCO World Heritage Old Town. You can't build a tram through there, you can't have scooters standing around. In China, where they are building it on a greenfield site, we are talking about completely different means of transport. In other words, the characteristics of mobility, what do you want to promote, what do you want to shift, it has to be local.** This cannot even be decided on a nationwide basis. These must be conurbations or metropolitan regions. These are the units for it. We don't have a metropolis in Switzerland, but (city), or the greater (region) area, is certainly where you have to say we have to do it from a single source. Public transport is very important, as is it cross-subsidised, and how do we involve the peripheral regions. How do we integrate the areas that may not have a scooter, but still want to go to the city? **This is a political decision, and then, of course, under the current discussion on the subject of energy and energy efficiency: Yes, what kind of transport do I actually want, is mobility infinite, should mobility be infinite? Should you be able to be infinitely mobile?** Here we have triggered a lot of leisure traffic with (case). The scooters are cool, the (company) are cool. That's where we triggered leisure traffic, where I say, is that intentional? Again, this is not decided by the provider, but by the city. Therefore, what kind of mobility do we want, keep this balance, which is necessary professionally. Now home office is coming much more, what does this mean for transport systems. Tram and bus, they are designed for peak times. How can we break peak times? How do we manage to relocate them? It would be sensational if we could say that the public sector would save on three trams in (city), for example. We have about 50 and they are very expensive to buy, and the large quantity is primarily purchased for peak times. Here, however, you could transport people with scooters and bikes during this time, who might otherwise be standing around at nine o'clock in the morning. Well, if it rains, it's a problem. These are things where I say, but what is needed above all is a change in mindset, that all players in mobility want to optimise the system together and agree to the financing accordingly. I've already hinted at it, (case) is becoming at the moment, we don't sell (company) tickets, we sell network tickets and get something back from the pot and that is measured by beginners, i.e. by passengers in public transport. This means that if (case) convinces ten customers to take the scooter in the morning instead of the bus, we lose money. We don't get paid for the fact that we might come up with a better overall mobility solution for the city or the customer. **This could be a Switzerland-wide peculiarity, but there is a real need for a mindset change that all players in the conurbation pull together and the cities should put all mobility out to tender, or they should be able to shape and pay for this construct. However, this is really a very broad desire for the designer of mobility to pay, according to quality, according to customer satisfaction, and not now, whether a means of transport is used or not. Because then he is again**

interested in promoting his own means of transport as far as possible, or to make the other means of transport bad in the worst case. That's really on a philosophical level, my train of thought, and then I'm convinced that a MaaS system, however designed, makes a contribution to a more liveable city or conurbation.

JG 1:15:42: Yes, I think that's very good, the definition and also important to distinguish that mobility happens locally, because mobility is so different, e.g. in China and in other countries in the USA it is different again, in Brazil it is different as it is here. That's why it has to be solved locally first and of course this mindshift is necessary in the city. But then, of course, for tourists visiting a city, to know what mobility options I have available now. The city can then also promote it, can offer specific tickets. In Munich, for example, for the Oktoberfest, they could have offered something and that's how I think it has to be designed in the future. And what is also being discussed a bit in research at the moment is so-called roaming. MaaS roaming means that you then have to travel between different cities, as is now the case with mobile communications, where you know it: You go to another city and then you want to have Internet there. This is also a big challenge for the future: How do you get there now, if these platforms work at some point in the individual cities or even across areas, how do you get a kind of roaming so that you can switch quickly. Yes, these are very exciting questions about the future and that's why I find the topic super exciting.

I2 1:16:58: We had already considered the topic of roaming. We actually had in Switzerland, although there were only three cities, but for example (city) were active in even more cities. With our subscription you could also travel in these cities that were not connected to us at all. But no one knew that. We also wanted to say, can't you do the same, I don't know what's going on in Munich, but there's (company) in (city). (company) is the association and if you have a (city) monthly ticket, you can travel for free in the (city) network, but not in (city), and not in (city), because there are other associations. Couldn't you also say about (company) that you can use public transport for this city, another city with your monthly subscription? So, a Munich man who has a Munich MVV subscription that he can then go to Cologne. Technically, this is not a problem at all, but there are still political and financial hurdles, if only in public transport. But I think (company) would be much more suitable for the time being. I believe that they can move us public transport people to think out-of-the-box about their way of thinking much more. I heard about roaming from electromobility, I was on the subject of electromobility for a long time and it was the same there. Everyone had their own charging card, and after the first offer, it will take another ten years, guess until you have a solution. So, from there, that would also be something: you could use your subscription worldwide. But then you need a contractual integrator who has to be paid for by someone (that's where it gets crazy). So, one step at a time! (both laugh)

JG 1:18:43: Yes, great, we're through with my interview. Thank you for your time!

Appendix J: Future Prospects for MaaS

This last appendix derives prospects for MaaS. Based on the cross-case learnings and success factors, the participants of this study have been asked for their prospects concerning MaaS.

For the thematic analysis, the barrier themes have been grouped into three inductive themes, with nine subthemes introduced in more detail in Table 62. In this subsection, those themes are introduced and then discussed with empirical evidence collected through the interviews.

Table 62. Overarching Cross-Case Prospects for MaaS

Themes	*Subtheme*
Technology and Data Prospects (TDP)	*(TDP1) Intelligent and Automated Mobility Settlement*
	(TDP2) Business to Business (B2B) – Mobility Budgets
	(TDP3) Modularity and Inclusion of Other Aspects
	(TDP4) Technical Improvements and True Meta App for Mobility
Social and Cultural Prospects (SCP)	*(SCP1) Fairness (Level Playing Field) and Inclusion*
	(SCP2) Market Saturation and Mindset Change
Policy and Regulation Prospects (PRP)	*(PRP1) Control Instrument and Tool for City Planning*
	(PRP2) MaaS Roaming
	(PRP3) Questions of Ownership and Certified MaaS Provider

(TDP1) Intelligent and Automated Mobility Settlement

The first emerging prospect was Intelligent and Automated Mobility Settlement (TDP1). In future, this will be an essential factor that needs to be considered when building a MaaS platform, as it allows the customers to use the different mobility services conveniently and cost-effectively.

The term intelligent means that a user can enter or use any mobility service offered in the city or region without worrying about which subscription or payment method the user chooses. The system intelligently determines which fare is the best one and thus automatically settles the mobility charges. The system uses fare caps and other information about the mobility services network in the calculations.

Evidence shows that the MaaS providers wish for functionality like this. I11 sees “the long term, smart and convenient ticketing” (I11) as necessary. For I2, it became clear that “the subscription is the second priority” (I2). The first one is to offer pay-per-use that automatically determines the fares. I15 sees the need to either make a “post payment using your contactless card or with using a mobility phone to tap on and off at the start and end of a journey” (I15). For example, the weekly fare cap can be identified and paid-as-you-go. In the future, I15 reflects that “selling rail ticket and bus tickets is not something that we really want to go towards. Because we do not want people to buy a ticket, we want people to trust they are going to get the best value fare and convenience of tapping on and off” (I15).

For example, the pricing strategy could also be adapted by paying less for sustainable modes that align with societal goals. However, it is also recognised that achieving that might not be easy because that will “need complex commercial agreements to put that in place” (I15).

Still, there is the need to put the user in the centre and try to overcome such a barrier by making it easy and user-friendly for them. Thus, intelligent and automated mobility settlement will be an essential aspect of MaaS in future.

(TDP2) Business to Business (B2B) – Mobility Budgets

Another prospect that emerged has been the extension of the MaaS into the corporate mobility world: Business to Business (B2B). One example is mobility budgets that can be introduced into the platform.

Through mobility budgets, companies can provide their employees with a certain amount of mobility budget, which then can be used to organise their daily mobility needs. I6 describe mobility budgets as "trying to create a product for businesses that would basically pay a retainer for employees' mobility costs and then the employee himself could choose where he would spend it" (6).

As part of customer research for the MaaS platform, I10 arranged a mobility budget trial. For that, they invited 80 people and gave each person £3,000 worth of travel credits to scrape their cars. The results of this trial provided valuable insights into the design of cooperate mobility budget and informed: "how we might do things and things we might try" (I10). Here I10 concluded that such incentives, discounts, rewards, and gamification would influence future user behaviour to adopt MaaS.

In this context, it will become increasingly important to understand which types of incentives work best with which types of people. For example, I9 was thinking of enabling corporate mobility by supercharging the public infrastructure "by enabling or placing networks at the hospital campus, for example" (I9). Another example provided by I13 is to include mobility practice "into the employment conditions for a number of employees" (I13).

With that, employers could fund or reward the use of sustainable transport. However, from the perspective of I13, "that takes a lot of time and a lot of hassle and perhaps also a lot of government regulation" (I13). Nevertheless, mobility budgets, especially in the corporate world, can help to change user behaviour and incentives the user of sustainable forms of mobility.

(TDP3) Modularity and Inclusion of Other Aspects

The MaaS platform will likely connect to other services besides mobility services. Hence, it could create easier transitions, acting as a “smooth jump-off solution” (I1). This will be enabled by taking a modular approach in the MaaS development. The MaaS platform can act as a connector, taking other actors’ modules and integrating them into the platform.

This acting as a connector is underlined by I9, who states that “we need to make the platform even more of a connector strip, in order to be able to plant modules, to be able to exchange modules, to be able to onboard providers more quickly” (I9). I5 expects that there will be “an easy-to deploy and customer frontend for individual cohorts […]. There would be these other apps that use the common components with their own unique elements to them” (I5). However, this will require strong partnerships among the actors but could “provide new products and services for customers” (I18).

These new products also facilitate the inclusion of other aspects beyond mobility. For example, I1 mentions connecting the MaaS platform with leisure activities, suggesting buying “my cinema or concert ticket” (I1). I16 extends this vision to retail and healthcare services, mentioning Hong Kong and the Octopus card as examples. The Octopus card acts as a “token where you put credits on, travel, and tap to transport, but it also gets used with payment to access the services” (I16).

Another example is China with WeChat. MaaS can be seen as a module, “as one component of their wider offering” (I16).

From a user perspective, I6 sees the platform’s future as a “mobility partner to use for everyday needs” (I6). This vision of I3 is to “access a MaaS platform and just have everything in there that I need for my daily live” (I3). I17 describes that MaaS can help to get more accessible throughout the day by combining information about mobility, navigation, payment, and restaurants. The MaaS platform of the future should be “not just technologically based but also user based, which means it understands what the user wants in a specific area and at a specific time. That would be the epitome of MaaS” (I17).

In conclusion, modularity, and inclusions of other aspects in MaaS will become cortical in future to enable a smooth integration of actors and achieve a personalised user experience.

(TDP4) Technical Improvements and True Meta App for Mobility

The last prospect which emerged has been technical improvements and an actual meta app for mobility (TDP4). In future, the MaaS platform must be technically advanced and reliable to be successful. I1 emphasises that especially “as far as routing is concerned, we simply need to get better […] so that I do get entire router chains routed with the reliability that my next vehicle will be there” (I1).

Next, MaaS needs to improve towards “personalised advice-giving to the people” (I11). The platform must be able to respond if events are happening quickly or if there should be any issue “with the line and it is not working” (I11). All actors in the MaaS ecosystem need to inform in future based on real-time data if “they have interruptions and things like that” (I12).

This will help to improve information and alternatives in case of disruptions making the platform trusted and reliable among the users. It is evident that if MaaS “compete or at least has a similar offer to owning a car, MaaS will succeed on a large scale (I13). Thus, if MaaS technical matures over the following years and becomes more reliable with real-time data, MaaS will succeed.

These technical improvements will help MaaS help to become an actual meta app for mobility in future. This means that MaaS should “put together all relevant modes of transport in a modular way” (I2). For the future, this means that the solution “should have all the providers within the city to be integrated there” (I6).

From a user perspective, a MaaS platform should be possible to consume in one app, having to “open my eyes and look at eight scooter providers” (I2). Further, an actual meta app will help to “compare and contrast all the different options” (I5). The future MaaS platform can then “show the opportunities to the people, […] it can advise you on the mode of transport” (I11).

Ultimately, I15 imagines the future of MaaS as a fleet of “autonomous demand-responsive vehicles responding to customers in real-time” (I15). I16 thinks “whether or not you are talking about mobility, or the service is in some ways irrelevant […] it is mobility to access services” (I16). Hence, a future MaaS platform must use all relevant transport modes and make the most of all mobility options and the transport network in a local city, a broader region, a whole country, and internationally across countries.

(SCP1) Fairness (Level Playing Field) and Inclusion

In the future, MaaS needs to become a level playing field for all MSPs involved and be inclusive for the users. I13 outlines that the MaaS provider should be an independent company, “public transport operators are both MaaS providers, which is unfair in my opinion, it should probably be separate companies” (I13). Here, I13 sees the need to create a fair level playing field, “which is not the case now” (I13).

According to I4, the key to achieving that is “open markets and fair competition […], in some cases there will be cities providing services, and in some cases, there will be private operators, but I think the key is that […] it has to be fair” (I4). As a result, the MaaS business ecosystem should be open with an open market for everyone. I4 adds that such an open ecosystem “will have a kind of legal framework, which is setting fair rules to everyone, but then we have this smaller data sharing network” (I4). In such an open MaaS ecosystem, neutrality becomes an important aspect.

I6 indicates that providers are “forced to think about bigger pictures and ideas that affect the mobility overall” (I6). I8 adds that the public provider should not lead investments in infrastructure and the creation of mobility hubs but rather “be an ecosystem of national or local providers” (I8).

However, other cases report that neutrality already plays an essential factor for them. For example, I9 emphasises that “we are simply a neutral platform. Neutrality is also an important aspect, where we juxtapose the offers and give the users the possibility to choose according to their needs in order to book correctly […]. As far as mobility is concerned, we see ourselves as a spider in the web. We don’t see our mission as favouring one player or another. We cannot do that, and we cannot legally do that” (I9).

Also, I10 reports that neutrality is essential to them “I think there may be some scepticism because we run the metro service and we run the cycle hire. So maybe some players might think, are we going to try and push that more? That’s not the case at all. We’re going to push all things equally and try to push all the all-public transport and active transport and shared transport” (I10). In addition, I18 reports that their “goal is to provide a level playing field between the operators […]. The only exception is a Combined Authority; we want to promote something because it is for the public good” (I18). However, as neutral as the platform provider want to be, it becomes necessary also to make the technology fair and neutral.

For example, I16 highlights the topic of algorithm regulation by asking interesting questions: “How do we ensure that they don’t get a deal or partnership with Uber so that every recommendation by default gets an Uber? How do we make sure that certain routes or journeys affect, like one mile and two-mile journeys, aren’t recommending a car or other modes that cannibalise active travel?” (I16).

It becomes clear from these questions that creating a level playing field will be a challenging topic in the future. While the public providers try to make it already fair, there is still a long way to go to make it fair.

Besides fairness and establishing a level playing field, inclusion will become increasingly important. Inclusion ensures that all users have access to mobility services. One example, I3 mentioned that the future MaaS should target an inclusive ticketing process with easy check-in and check-out procedures. The idea is that “you do not have to think about where I have to book which ticket or whatever and that the systems recognises that” (I3). In this context, I4 also mentions access to the interfaces as an important factor for inclusion, “when I tried to buy a ticket, it is displayed first in German” (I4).

Another factor of inclusion that needs to be considered more in future is the price of the mobility services offered in a MaaS platform (I12, I14, I15). Although many users are hoping that MaaS will lead to cheaper travel, it is still considered a challenge:

I12: "I hope there will be cheaper trips, but cheaper is always more difficult."

I14: "there must be some competition to lower the price […], especiallly in our country, the services are still a bit expensive. So I would like to have more, not cheaper, but more affordable services for the citizens in our city."

I15: "I wouldn't pay for an all-in subscription because I can't make every journey on transport. I can use public transport for maybe 10% of my journeys at most. So I would never commit to an all-in subscription."

As a result, MaaS providers have to adapt and improve their business model in future to offer more affordable services for all users. In conclusion, MaaS needs to ensure that the services are inclusive and thus accessible to all users, even if they live outside a city. I18 recognises that the "idea around MaaS has evolved and maybe does not always work for the customer" (I18). For this reason, a fair and inclusive MaaS platform will become more critical in future.

(SCP2) Market Saturation and Mindset Change

The future of a MaaS will be based on a saturated market and require a mindset change (SCP2). I1 predicts that "the market will simply be saturated and then not much will happen, but I believe that another switch will have to take place towards certain forms of mobility" (I1). I9 agrees with this prediction pointing out that "this market simply changes and professionalises even more […]. This market will simply become a bit more mature, and we will all benefit from that" (I9). This market saturation will be achieved as the future of MaaS platforms is open, meaning that there will be a "shared ecosystem […] joined and integrated together" (I14).

This also comes back to the previous prediction about MaaS roaming. Users expect the MaaS business ecosystem is working together closely: “I do not want to have another 20 applications on my phone. I would like to have one for whatever I need. I do not want to think if this bike is pink or grey. It does not matter” (I14). Further, I4 follows that argument but adds the factor of individual app preferences, “I want to use one app, which gives me everything that I need, but when we think about users, not everyone wants to have the same kind of app” (I4). Such market saturation can be achieved through “commercial players coming into the space as pure aggregators” (I15). This will result in the “MSPs kind of move on closer with public providers and deliver this” (I18). Still, I18 predicts “consolidation through acquisitions and mergers, but also through some closing which is just a natural part of the market developing from a quiet, immature place” (I18). Thus, consolidated, more mature MaaS platforms are likely to establish in future.

This will also need a mindset change both from the users, but also from the MaaS providers. Here, a rethink is needed that all actors in the ecosystem are working together and that the cities are taking a neutral position by tendering and co-designing the city’s mobility strategy. I2 outlines this by saying, “all the players and the cities should pull all mobility out to tender, or rather they should be able to shape and pay for this construct” (I2).

To achieve that, there should also be a change in city incentivisation. For example, I2 highlights that in future, “the mobility provider is paid according to quality, according to customer satisfaction, and not as it is now whether a means of transport is used or not” (I2). This only creates silo thinking and makes public transport operators mainly “interested in promoting their means of transport or, in the worst-case scenario, making the other means of transport look bad” (I2).

I8 thinks that such thinking can be overcome, “the public needs to purchase a national platform […]. It does not necessarily have to be one, but there should be a couple that is open and easy to access” (I8). Working together nationwide on mobility services with unified incentivisation systems will “encourage the market to find areas of value for the consumer […]. That moves the journey off the road and onto other forms of shared transport” (I8). Thus, this can help to establish a data-led tool for behaviour change. I10 concludes by saying that the vision is “to get to a place where what we are offering in terms of incentives, in terms of modal recommendations, whatever it is that is personalised and tailored to you as the user” (I10).

(PRP1) Control Instrument and Tool for City Planning

Another prospect that emerged from the cases is MaaS being a control instrument and tool for city planning in the future. MaaS can help to shape and control the mobility options a city can offer to their citizens.

For example, I16 imagines a future scenario: "90-95% of people within the city region are now using the MaaS app. You now have a complete picture of mobility demand and how they are using it" (I16). This will help open up opportunities to manage mobility demand better and influence user behaviour.

I2 describes MaaS in the future as an "important tool in the toolbox of the city or the public sector to shape transport the way they want" (I2). Here it is emphasised that "every municipality, every community, every country has a different kind of transport policy or mobility goals" (I2). Thus, MaaS will help the different cities enforce societal goals by setting out incentive functions and "regulating the rules of play when new modes come to a city" (I16).

Besides that, MaaS can be used to respond to events in the cities or manage traffic, "you can react flexibly with a MaaS system by adjusting prices, for example, if there is a trade fair or a football match" (I2). This future vision has also been shared by I9, who says that "we already doing that today […], we react to things that happen in the city" (I9). For example, if an event is happening, the platform of I9 can dynamically adapt and scale out its mobility offerings.

This vision is also shared by I15, who emphasises that "understanding all the movement flows helps to bring that back into the design of the transport network. And not just the design, but there may also be some operational decisions" (I15). For example, if an event occurs, the capacities can be shifted, "let us redistribute, and bring another bus from over there" (I15).

In addition, the city can react with personal incentives like coupons and targeted communication. In this context, I11 brought up the idea that "big events in the city you can suggest using certain forms of mobility" (I11). I16 names that the e-scooters have been "the first mode we have complete control over where it can go due to the digital underlay of it" (I16). In the future, other modes can likely be as controllable as micro-mobility services, offering new possibilities for managing mobility.

For this reason, data sovereignty will play an essential role for the city as the provider of a MaaS app (I7). The cities can also use this data as "a tool to compare your transport network and all the things that are going on here; your One Stop Shop" (I5). Such identified gaps can then be combined with other information gathered by the platform for city planning supported by "numeric evidence to support the business case" (I5). This information can then be used to build a digital twin with real-time transport information about the city.

I9 imagines MaaS helping to realise a vision of urban planning, that, for example, through "a click of the mouse […], new scooters will come here automatically, or I say I am going to put a no-parking zone here and then no more rental cars will park here" (I9). This vision has also been expressed by I11, who sees it in future as a tool to develop "specific parts of the cities […], which are not so well covered by public transport" (I11). This is shared by I10, who sees the need to link MaaS in future "to residential planning and new developments" (I10).

In summary, the participants have observed common sense around the potential future avenues for MaaS as a control instrument and tool for city planning. The future of MaaS lies in gaining insights into customer demand and mobile data and connecting it with infrastructure data to identify gaps in the network. This digital twin then helps to formulate long-term societal goals for cities, adjust the network and fares, manage the traffic, react to events, and finally make an informed decision to improve the infrastructure in specific areas.

(PRP2) MaaS Roaming

Another prospect that came up was MaaS Roaming (PRP2). MaaS roaming enables users to use mobility services of other MaaS platforms in different regions with the same application. Many future challenges need to be overcome to achieve that.

However, the participants of the cases saw this as an opportunity for their platform in future "there are other topics that I find quite exciting, that we actually want to be a roaming partner via blockchain technology […]. We all live in a world where we sometimes do not feel downloading new apps and apps and apps" (I7). Other participants report that in their cases, they already have a small MaaS roaming capability (I2, I3).

Here, I2 highlights "with our subscription, you could also travel in these cities, which were not connected to us at all. But nobody knew that. So that would be something: you could also use your subscription worldwide. But then you would also need a contractual integrator" (I2). I3 adds that, that I3 was using the solution, and it was "a real benefit for me, because I did not have to think about where I could take the solutions" (I3). In this context, I3 emphasises that MaaS roaming can be very beneficial, especially for tourists. Also, other participants report that MaaS roaming is a priority feature for their platform. For example, I12 reports that its vision is to create "an interurban platform" (I12).

Besides these optimistic views, insights show that creating MaaS roaming nationwide or globally is challenging (I5, I6, I9, I11). Here I6 indicates that "cities differ in the service they provide and endpoints they have, so maybe some similar solution could have the deployments similar per city, but they definitely cannot unify them all. Maybe I would consider having good country-wide solutions" (I6). I11 agrees and says, "it is super hard work even to cover everything around our city. Moreover, every city has these speciality things. However, if we don't have it in our city either or we don't have it in our country. How could it be done for four countries?" (I11).

I9 also sees issues regarding responsibilities and competition to develop MaaS roaming, "we are the public transport company and not the German public transport company and even if some public transport companies would certainly like to see that […]. There are others who say, well this is my market, and I would like to set the rules here, and I also have the competences" (I9). I5 sees MaaS roaming as "let us walk before we can run" (I5). Still, the possibilities can be generated when MaaS roaming works are immense.

The way to the future will be roaming partnerships and creating open national and international markets. For example, I4 sees that MaaS roaming should be based "on the national law that you have to grant access to interfaces" (I4). I13 even thinks further, saying, "I would never think of a city-wide approach. I would always look at a bigger scale because we often forget that people do not just travel around the city […]. You would expect your own MaaS provider to also work in another city" (I13).

Also, I14 would like to see in future "at least one system for the state, for the country of for the main cities" (I14). As a result of that, MaaS providers should not monopolise the market but rather think of bigger-scale solutions that would enable MaaS roaming in the future. As an action point, I10 indicates, "I would be interested in speaking with our central government about this because now we have different regions trying different things. But how is that going to sort of match up? We know that people's journeys are not just stuck in one region" (I10).

I18 compares the current regional solutions with the EV charging space a few years ago, emphasising that interoperability between the solutions is ultimately needed. As a short-time strategy to enable MaaS roaming, I18 suggests establishing "at least interoperability in the accounts" (I18).

Ultimately, MaaS roaming will be a trade-off between establishing individual solutions first or directly going for nationwide or even global MaaS solutions. To achieve MaaS roaming in future, an open MaaS business ecosystem is critical, with the standard defined by the MaaS providers, "it is all about creating a bigger marketplace for everybody" (I8).

(PRP3) Questions of Ownership and Certified MaaS Provider

In the future, questions about ownership and what constitutes a certified MaaS provider will become increasingly important. Among the participants of this study, different opinions are existing who should own the MaaS platform in future.

I7, I14 and I16 say that a public provider should own the MaaS platform in future. For example, I7 believes that a public-private partnership will be the future and that "the city or whatever must always be the owner, must be well equipped to be able to bring about this change and at the same time connect the private companies" (I7). Further, I7 explains that the city or urban transport authority must have data sovereignty over the platform in order to be able to improve their services to the end-user, "I think nothings is more difficult than making services better for the end customer than not having the data to see what is happening" (I7). I14 agrees with that and outlines that they like to "create all those critical systems and keep them in our hands so we can operate it" (I14). I14 emphasises that their citizens trusted the city as a MaaS provider "because we can keep equality" (I14).

In contrast to these opinions, mixed results have been outlined by I6 and I18. For example, I6 sees that "there should be some sort of symbiosis between the public and private here" (I6). Thus, I6 sees that the MaaS platform will be "overseen by some sort of government agency, but definitely run by a private one" (I6). I18 is not too worried about the delivery model "whether it is the public sector, private sector, or mix, it should be the right model that works in your area" (I18). For I18, the "support and input from the MSPs in the region" is essential because "there is no MaaS without them" (I18). In the future, I18 thinks of creating "a separate company partly owned by the transport providers and the authority to continue delivering this" (I18).

Participants I3, I5 and I8 question the role of public providers in the future. For example, I8 says that public providers are “in some ways leading the MaaS debate, whereas they should have been supporting the MaaS debate” (I8). What I8 points out with that is that the public providers acknowledged MaaS as technology to modernise their ticketing systems and tried to put their “organisation at the heart of mobility of the city, and failed to see if their job is to get more people to use public transit, they should make access to public transit as easy as possible” (I8).

Thus, the public provider should not develop their own MaaS platform but distribute their services “to as many channels as possible” (I8). Also, I3 questions, “how much the city or the cities must then still be involved” (I3). If everything is open, a MaaS platform provider can come to a country, “they can get this web service from the public provider, they do not have to ask anyone” (I3).

However, this openness is criticised by I5, outlining that the value proposition of the city or local transport authority is marginalised “if everything is open and you can have a one-man developer sitting in their bedroom, creating a journey planner” (I5). As a result, it will be interesting to see the development of ownership of the future MaaS platform, mainly how regulation will be used in this context.

In the context of ownership, participants have mentioned the code of a certified MaaS provider. In future, establishing the definition of certified MaaS providers can be very important. Because of the previously mentioned points, there is a concern that “everyone has a MaaS solution, but not one is doing very well because there are too many MaaS solutions” (I10). A certified MaaS provider is an approved actor in MaaS, proving his willingness to participate in societal goals such as data protection, security, data-sharing, and policymaking (I13).

For example, “all certified MaaS providers can easily participate with certain incentive programs form a city. Each city can do it differently because they all have their own goals. But you do not need to select every time a single MaaS partner to do that” (I13). Finally, a certified MaaS provider demonstrates a significant commitment to privacy and other societal goals. Such a certified MaaS provider can help to build a MaaS platform more efficiently and more trusted by the users, “making mobility more of a public asset” (I13).