How can we build Trust and Collaboration among Mobility as a Service (MaaS) stakeholders?

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STATEMENT OF ORIGINALITY

This is to certify that to the best of my knowledge; the content of this thesis is my own work. This thesis has not been submitted for any degree or other purposes.

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged.

Signed

Thiranjaya Kandanaarachchi
25th January, 2024

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The journey of completing this thesis is a memorable learning experience shaped by a mix of tasks that are both satisfying and rambling, yet ultimately enriching. Such a long journey would not have been possible without the support of the people who were around me during this period. Their assistance was instrumental in navigating through the sea when it was rough.

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ABBREVIATIONS AND ACRONYMS

CaaS - Collaboration as a Service

CFM - Common Factor model

CGTM - Constructivist Grounded Theory Method

DRT - Demand Responsive Transport

EFA - Exploratory Factor Analysis

HCC - Helsinki City Council

HSL - Helsinki Public Transport Authority

IAG - Insurance Australia Group

IATA - International Air Transport Association

IoT - Internet of Things

ITF - International Transport Forum

ITLS - Institute of Transport and Logistics Studies

ITS - Intelligent Transport Systems

MaaF - Mobility as a Feature

MaaS - Mobility as a Service

MRI - MaaS Readiness Index

PCA - Principal Component Analysis

PPP - Public-Private-Partnership

PTA - Public Transport Authority

REFA - Regularised Exploratory Factor Analysis

SaaS - Software as a Service

SMT - Sydney MaaS Trial

TfNSW - Transport for NSW

TSP - Transport Service Provider

WBCSD - World Business Council for Sustainable Development

WMS - Whim MaaS Scheme

ABSTRACT

The concept of Mobility as a Service (MaaS) has grown in popularity resulting in a number of MaaS trials and solutions in recent years. The development of sustainable business models in the long run, which generates shareholder benefits, is one of the key concerns that MaaS schemes still need to address. Extant literature indicates that lack of trust and collaboration among the key stakeholders in the MaaS ecosystems is one of the key factors that hamper the formation of sustainable MaaS organisational models. This study investigates the factors that build trust and collaboration in a MaaS ecosystem using a mixed methods approach which consists of two phases. Phase I followed a Constructivist Grounded Theory approach using two MaaS case studies namely, the Whim MaaS scheme in Helsinki, Finland and the Sydney MaaS trial, in Australia to understand how stakeholders of the MaaS ecosystem perceived the factors that build trust and collaboration. Data was collected through semi-structured in-depth interviews conducted with the representatives of key stakeholders in the two MaaS ecosystems. Two conceptual models were developed for each case to illustrate how the constructs that emerged through the analysis interact with each other in building trust and collaboration. Phase II was based on an international survey of professionals with an interest in MaaS which is developed using the constructs identified in Phase I. The factors extracted in Phase II using Exploratory Factor Analysis (EFA) were investigated with the constructs that emerged in Phase I to identify a set of generic factors that build trust and collaboration in a MaaS ecosystem. *Appropriate legislation* that *facilitates open data standards*, the *capability of the partners*, *prior relationships*, *open negotiations* that lead to *win-win solutions* and *contract terms* that create both *accountability* and *flexibility* in the face of the varying circumstances, emerged as the key constructs that form trust in a MaaS ecosystem. It was evident that trust acts as the antecedent and catalyst for building collaborative space within a MaaS ecosystem. The *identification of stakeholder motives (commercial and societal), understanding among the partners, expectations management, having a shared vision or a common goal, identifying conflicts, having a MaaS champion* and *understanding about MaaS* emerged as essential for collaboration apart from the trust. Drawing on these findings, policy implications have been postulated for regulatory authorities to enable a conducive environment for MaaS implementation.

GLOSSARY OF TERMS

Constructivist Grounded Theory Method - A technique used to analyse a phenomenon using qualitative data to postulate major themes that are emerging from the data to develop a comprehensive framework to interpret the phenomenon.

Exploratory Factor Analysis - A quantitative technique which is used to synthesise the data and understand the latent factors. This employs dimension reduction based on the underlying correlations and patterns among the collected data.

ICT infrastructure provider - The entity that designs, develops and maintains the necessary ICT infrastructure for MaaS such as platforms and applications.

MaaS - Mobility as a Service is the concept of integrating all transport services (such as bus, train, taxi, ride-sharing, micro-mobility) into one platform where end users can plan, access, book and pay for their services using that platform.

MaaS integrator - The MaaS integrator is the entity that integrates all the services from the transport service provider and delivers them to the end user. MaaS operator and MaaS broker are also used to indicate the same entity.

Regularised Exploratory Factor Analysis - A variation under exploratory factor analysis that caters to small sample sizes through ridge regularisation.

PUBLICATIONS ARISING FROM THIS THESIS

1. Conference paper - Kandanaarachchi, T., Nelson, J.D., and Ho, C. Building trust and collaboration among the stakeholders in a Mobility as a Service ecosystem – Insights from two MaaS case studies, Thredbo-17, International Conference Series on Competition and Ownership in Land Passenger Transport, September 2022, Sydney, Australia
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4. Journal paper (under revision) - Kandanaarachchi, T., Nelson, J.D., and Ho, C., Conceptualising trust and collaboration in MaaS ecosystems, Transport Policy

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CHAPTER 1 INTRODUCTION

The concept of Mobility as a Service (MaaS) has been coined for almost 10 years. The hype it had, around 2016 – 2017, has now started to decline due mostly to the issues around sustainable organisational models and scalability. It is argued that the lack of trust and collaboration among the stakeholders in MaaS ecosystems is a key underlying reason behind these issues. The research in this thesis started in 2020 with the interest of understanding the validity of this claim, and if so, to investigate the factors that create trust and collaboration in MaaS ecosystems. This chapter serves as the starting point for the study, offering an explanation of MaaS and the nature of stakeholder relationships within the MaaS ecosystem. Section 1.1 introduces the concept of MaaS, followed by section 1.2, which explains the MaaS ecosystem and organizational models, emphasizing the importance of collaborative relationships among stakeholders by drawing on existing literature. Section 1.3 presents the research questions and the underlying reasons that motivated their design and development. The chapter concludes with section 1.4, outlining the overall structure of this study.

1.1 What is MaaS?

MaaS is a concept with promise as an innovative transport solution for integrating complementary transport modes to create sustainable travel choices, fuelled by disruptive technology. MaaS can be described as a service which is delivered by integrating different forms of mobility services (buses, trains, taxis, carpooling, car sharing, ride-sourcing, bike sharing) through a single platform that allows the users to search, plan, book and pay for the transport services (Hensher et al., 2020; Kostiainen and Tuominen, 2019; Lyons et al., 2020; Sochor et al., 2018). Dynamic and complex travel behaviours, coupled with individual requirements, mandate the MaaS solutions to be technology-driven, innovative, flexible and agile while being user-friendly in fulfilling diverse travel needs (Jittrapirom et al., 2017; Kostiainen and Tuominen, 2019; Smith and Hensher, 2020). In a bid to establish a benchmark definition Hensher et al. (2020) describe MaaS as,

"A framework in any geographical jurisdiction (urban, regional, rural, national and global) within which all mobility means (private and public) must be able to be fully integrated through an integrator (public or private) responsible for maintaining or supporting any digital platform for booking, payment and feedback, who can ensure that suppliers of (multi-modal) transport services and non-transport services can support the

preferences of end-use customers through PAYG and subscription plans, subsidised or not by the public sector, designed to obtain sustainable outcomes."

Most asset-based industries are moving towards service-oriented organisational models. MaaS aligns with this upcoming trend of shifting from an ownership-based economy to a sharing economy (Gonzalez-Feliu et al., 2018; Liyanage et al., 2019) and is thrived by collaborative consumption and is enabled by the megatrends in digitalisation (Lajas and Macário, 2020; Liyanage et al., 2019). This requires continuous innovation in service design to complement the change towards concentrated ownership structures (Pasimeni, 2021). Although it has been almost 10 years since the inception of MaaS the development and implementation of MaaS are yet found to be at preliminary stages even in the European countries where the concept has emerged (Bandeiraa et al., 2022). MaaS is still used as a slogan or a buzzword by some government authorities and transport operators with a fear of missing out (FOMO) attitude (Lajas and Macário, 2020) which creates a manipulative perception of MaaS within society.

1.2 Context of the Study

A better understanding of the stakeholders and their roles in the MaaS ecosystem provides a firm point of departure towards the discussion about their roles, responsibilities and interrelationships. Typically, a MaaS ecosystem consists of users, transport operators, regulatory authorities, data integrators and analysts, technology and platform providers and the MaaS broker/aggregator; however, this can be extended to include non-mobility service providers ICT infrastructure providers, researchers, insurers, investors and media, passenger institutions, marketing and advertising firms (Arias-Molinares and García-Palomares, 2020; Polydoropoulou et al., 2020). Types of regulatory authorities may differ based on the governance structures that exist in different settings but usually include Public Transport Authorities (PTAs), Public Agencies, local and governmental authorities, and city councils (König et al., 2016; Smith and Hensher, 2020; Wong et al., 2020). The combination of both public and private stakeholders results in inevitable conflicts due to the diverging interests and expectations inherent to their institutional and operating structures (Mulley and Nelson, 2020; Smith et al., 2018a, 2018b). Polydoropouloua et al. (2020) have ranked the importance of different (or actors) in *setting up* the MaaS ecosystem on a scale of 1 to 5 as depicted in Figure 1.1 with reference to a study conducted in Great Manchester (GM), Budapest (BUD) and Luxembourg (LUX) in Europe in the pre-

implementation phase of MaaS. These relationships would be interesting to study from ex-ante and ex-post perspectives as an attempt to validate the findings in an operational context.

Even though MaaS is considered a revolutionary transport solution, there are studies which argue that MaaS is a point at the evolutionary continuation of integrating different transport means (Lyons et al., 2020; Mladenović, 2021). These studies perceive the mobility integrator role as the only innovation which is capitalising on the role of technology. Generally, MaaS models introduce an intermediary mobility broker to the prevalent transport ecosystem. The mobility broker integrates mobility services offered by different transport providers to provide a seamless and more efficient transport solution for the end users (Kostiainen and Tuominen, 2019; Smith et al., 2020). Earlier studies of MaaS, mainly from the Nordic countries, argued that public stakeholders, such as the transport authority, should take the MaaS broker role (Smith et al., 2018b), given the need to incorporate societal goals in MaaS offers; however, more recent studies support a private stakeholder taking the MaaS broker role (Hensher et al., 2023; Smith and Hensher, 2020; Smith et al., 2020). The latter envisages the need for continuous innovation which is harder to achieve

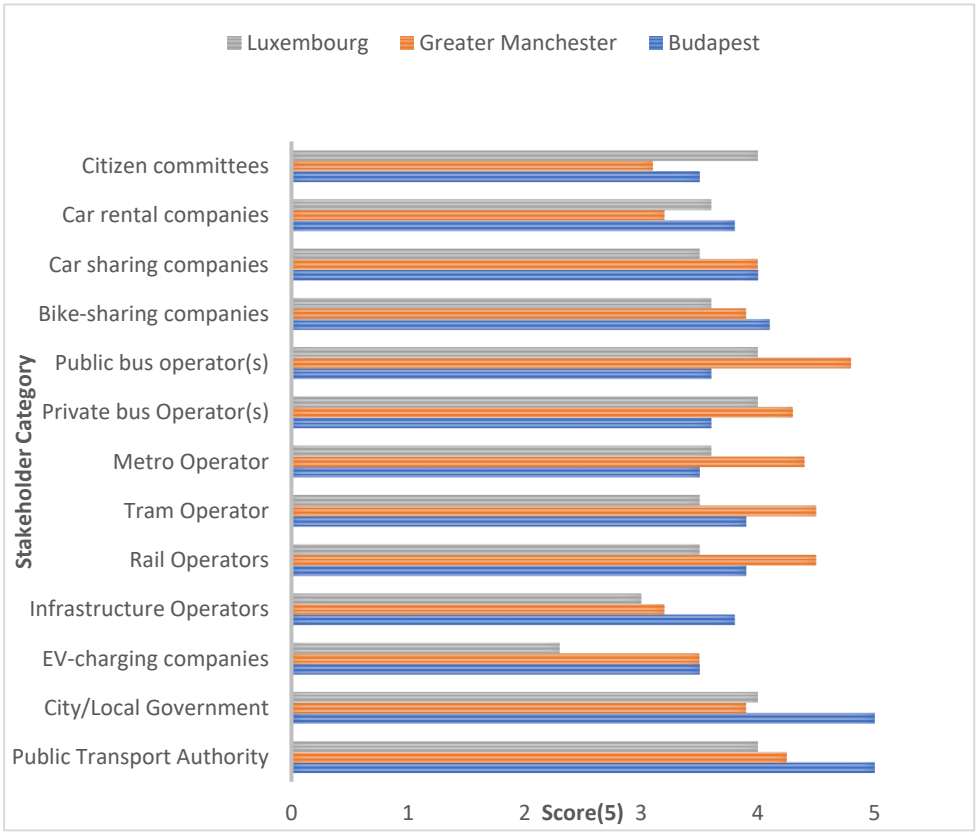

Figure 1.1: Key actors of the MaaS ecosystem pertaining to their importance in the three study areas, Polydoropouloua et al., 2020

with the rigid hierarchical structures in typical public institutions (Hensher et al., 2020; Smith and Hensher, 2020).

As with many new concepts, MaaS requires suitable organisational models that fulfil the expectations of the involved stakeholders to operate effectively, efficiently, and sustainably. There are different organizational models proposed for a MaaS ecosystem in the extant literature, some using empirical evidence and others based on conceptual methodologies. The existing MaaS models can be broadly categorized as open-market models and regulated models. Open market models could either run through MaaS brokers or by alliances of the existing operators (König et al., 2016; Merkert et al., 2020; WBCSD and ITF, 2020). One key drawback of the open market model is its sole focus on profitability, with little to no incorporation of societal goals that could be achieved through MaaS which can be seen as a consequence of a lack of consensus on the definition of MaaS. Regulated models can either be operated through a public, private, or a partnership between public and private sectors while being governed by regulatory authorities. Government contracted MaaS model operated through a Mobility broker, who is preferred to be a private actor, is suggested by Wong et al. (2020) in an attempt to propose a conceptual framework for MaaS organisational models. MaaF is a more recent proposition which leverages the multi service aspects of MaaS placing well established companies such as insurers, bankers etc. as the providers of MaaS (Hensher and Hietanen, 2022). The latest proposition is for the formation of MaaS consortia as part of an advanced government procured MaaS organisational model based on a competitive tendering mechanism which is assessed based on comprehensiveness, cost and achievement of societal motives (Hensher et al., 2023). A more detailed discussion of organisational models proposed in the literature is provided in the section 2.3.

The nature of the MaaS organisational model depends heavily on contextual factors related to the existing transport landscape, ranging from transport policies to individual attitudes. Studies to date show that the smooth diffusion and progression of MaaS relies on the formation of a suitable ecosystem composed of a plethora of contextual factors covering legislation, technology, availability of transport modes, organizational structures, commercial viability, geography, etc. making it an arduous task to find a universally accepted MaaS solution (Arias-Molinares and García-Palomares, 2020; Mladenović, 2021; Smith and Hensher, 2020). The diffusion and development of MaaS are also affected by cultural context, particularly the attitudes of people regarding private cars and shared

modes, including public transport, Uber, taxis and car-sharing. In addition, the roles of the different stakeholders are directly impacted by the policies and regulations of a given state or territory in which MaaS operates (Smith et al., 2018b; Surakka et al., 2018; Wong et al., 2020).

This highlights the importance of understanding the necessary conditions that would enable a smooth deployment of a MaaS service in a given area. Goulding & Kamargianni (2018) have elucidated the need for the existence of prerequisites that would enhance the smooth diffusion of MaaS. From this, identifying and quantifying the prerequisites to evaluate the "readiness" of an area has been argued as important for the design, development, and implementation of MaaS. It should also be highlighted that, while fast-growing, MaaS is still a relatively new concept with only a limited commercial product hitherto, with most in-field trials being stalled instead of being extended to full-scale commercialisation. Thus, it is important to evaluate MaaS trials to understand the barriers behind scalability and full-scale implementation (Hensher et al., 2020, p. 67; Karlsson et al., 2020; Lyons et al., 2020).

Despite the differences in structuring and recognising the roles of different stakeholders, MaaS organisational models in general consist of several stakeholders who interact with each other to deliver a MaaS solution. Therefore, the collaboration between the partners is highlighted as an important factor which is essential for MaaS to propagate given the complex and diverse needs of the different stakeholders involved in a MaaS ecosystem (CIVITAS ECCENTRIC, 2020a; Gonzalez-Feliu et al., 2018; Guyader et al., 2021; Hensher et al., 2020; Merkert et al., 2020; Meurs et al., 2020). Given the critical roles of culture, stakeholder dynamics and institutions found in the extant literature on the design, development and diffusion of MaaS, (Smith et al., 2018b; Sochor et al., 2016; Wong et al., 2020) this study aims to understand the systematic formation of trust and collaboration within a MaaS ecosystem in such a contextual environment, based on real-world experience to date.

1.3 Research Questions

As is evident by the above discussion, trust and collaboration among the stakeholders within a MaaS ecosystem are emphasized as necessary for the development and implementation of a MaaS scheme. Therefore, it is important to study the mechanics behind trust and collaboration with reference to existing MaaS schemes. Hitherto, studies are less

focused on understanding and specifying the exact means of how trust and collaboration forms within a particular MaaS scheme.

Building and maintaining trust and collaboration is a complex process that depends on various factors that could be detrimental to creating such an environment if not handled appropriately. Hence, a better understanding of the mechanism and/or process that leads to the formation of a collaborative environment in the context of MaaS service delivery is vital. Some of the contributing factors are already revealed in the extant literature focused on the factors that hinder the development of MaaS, such as rigid and inflexible contracts, lack of synchronization between the motives of different stakeholders, lack of visibility in data, concerns about the ownership of the customer (Merkert et al., 2020; Mulley and Nelson, 2020; Smith et al., 2018a, 2018b). However, the factors that foster trust and collaboration, as well as the interrelationships among these factors at a systemic level, are yet to be discovered. Hence, the overarching objective of this research is to understand the factors that contribute to the establishment of trust and collaboration, and their interactions within MaaS ecosystems.

In light of this, the first research question of this study aims to identify a comprehensive set of factors and their impacts on creating a conducive environment for MaaS stakeholders to build and maintain trust and collaboration. This objective can be expressed in the form of a research question as follows:

RQ 1: What factors would facilitate building trust and collaboration within MaaS ecosystems?

While the need for trustworthy relations is emphasized in several studies, the process of forming collaborative relationships built on trust, with a focus on the different risks and fears among stakeholder groups, remains not yet understood. Furthermore, it is also important to understand how interactions among different stakeholders shape and induce collaboration while reducing conflicting situations. Hence the second research question is phrased as below.

RQ 2: How would these factors build trust and collaboration among the stakeholders?

The aim of *RQ2* is to understand how the factors identified under *RQ1* interact with each other in forming trust and collaboration within a MaaS ecosystem. Moreover, it is worthwhile to understand how the contextual setting impacts the emergence and presence

of the identified factors. This understanding would assist in conceptualizing the formation of trust and collaboration at an ecosystem level, considering the entire spectrum of stakeholders.

1.4 Thesis Structure

In answering these research questions this study has adopted an empirical approach led by the importance of addressing these questions using a more grounded approach. This spurred the use of different case studies of MaaS to understand how different contextual settings would shape the formation of trust and collaboration within the ecosystem. The study considered the entire spectrum of stakeholders involved in delivering a MaaS Scheme based on the Constructivist Grounded Theory approach. Subsequently, these findings are complemented by the results of an international survey using Exploratory Factor Analysis. The study is aimed at understanding the mechanics behind building trust and collaboration in a MaaS ecosystem The remainder of this thesis is organised as follows.

Chapter 2 presents the literature review. It begins with an evaluation of the existing MaaS readiness indices, followed by different reasons put forward by various scholars and industries that emphasize the need for trust and collaboration. The chapter concludes with some general theoretical insights related to trust and collaboration. Chapter 3 explains the research design and the methodological approaches adopted in Phase I and Phase II. The chapter further highlights how the results of the two phases complement each other to form and refine conceptual models that explain the formation of trust and collaboration in MaaS ecosystems. Chapter 4 illustrates the analytical approach for each phase, elaborating on some important analytical decisions with underlying arguments. Chapter 5 discusses the two conceptual models developed in Phase I, followed by the results of Phase II. Chapter 6 presents the policy implications derived from the findings of this research. The thesis concludes with Chapter 7, which includes a snapshot of some significant findings, followed by contributions and avenues for future research opportunities.

CHAPTER 2 LITERATURE REVIEW

This chapter investigates the role of trust and collaboration in MaaS ecosystems from scholarly work. The aim is to identify underlying factors that build trusting relationships among the respective stakeholders within the MaaS ecosystems which aligns with the definitive work mentioned in section 1.1. The chapter starts with section 2.1 which provides an overview of the user case for MaaS, followed by a discussion of how the existing literature on MaaS organisational models has considered the importance of collaboration in structuring the relationships among different stakeholders (sections 2.2, 2.3 and 2.4). Section 2.5 reviews the existing MaaS Readiness Indices (MRI) to elucidate the necessary preconditions stated by the developers of the respective indices that need to be considered when designing a suitable MaaS scheme. Section 2.5 also includes a discussion on the roles of trust and collaboration (or the lack thereof) in the development of these readiness MRIs. Section 2.6 references the broader literature regarding trust and collaboration in inter-organizational studies, examining its relevance in the context of MaaS. The chapter concludes with section 2.7, discussing the implications of the literature review for this study. Figure 2.1 illustrates the themes investigated in the literature review in a schematic diagram.

2.1 User case for Mobility as a Service

While market demand for MaaS is not the focus of this study, it is important to examine the case for MaaS from the user's perspective. There is only a marginal value in investing in sophisticated supply-side infrastructure and resources for MaaS if the public shows little or no interest in MaaS. In contrast, if market demand for MaaS is strong, some of the complex chicken and egg problems such as ridership vs. scale in MaaS would be tackled using a different approach which necessitates active government involvement rather than allocating such problems to the private sector alone. Like any digital service, the market demand for MaaS would depend on many factors, including design, marketing, price, function, and user-friendliness.

Regarding user-friendliness, Lyons et al. (2020) proposed 6 levels of MaaS Integration (LMI) taxonomy considering the cognitive effort that a user has to invest in at different levels of operational, transactional and informational integration across MaaS. The reasoning behind the taxonomy underlines the fact that the goal of MaaS should be to develop a mobility alternative to the private car which provides a seamless end-to-end

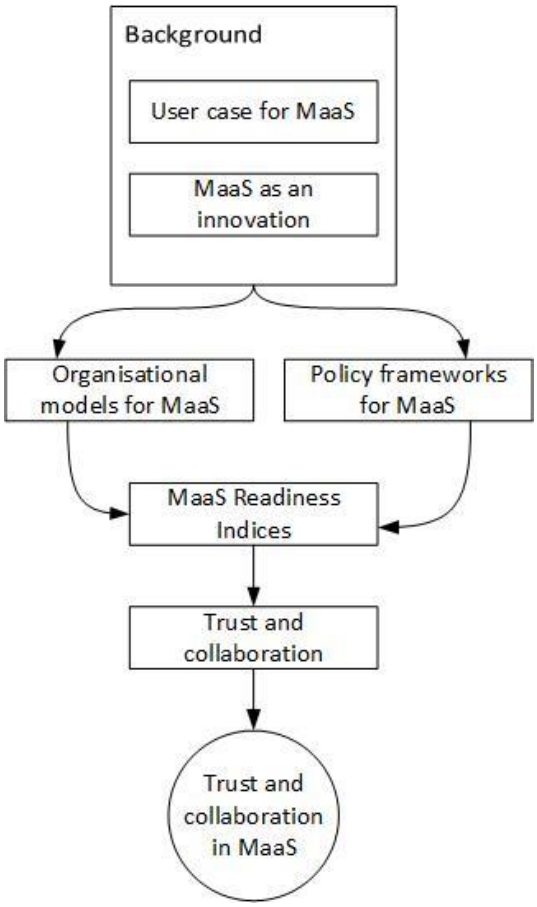

Figure 2.1. Themes investigated in the literature review

journey experience with the lowest cognitive effort (level 5). Further, this study questions MaaS's capability to change consumer behaviour by highlighting the fact that users are less likely to change their behaviour unless they are dissatisfied with existing mobility options or experience a change in their circumstances. This emphasises the need to understand the user needs comprehensively prior to the design and development of MaaS projects.

Ho et al. (2018) and Ho et al. (2020) have highlighted the importance of understanding the customers in terms of their socio-economic contexts and their current travel patterns to create customer-sensitive MaaS bundles. The latter study was conducted using participants from Sydney, Australia and Tyneside, UK found that over 40% of the sample would take MaaS as a subscription bundle rather than as pay-as-you-go (PAYG). The study advocates MaaS bundles over PAYG because mobility bundles promote sustainable travel behaviour while MaaS under PAYG does not. Also, the work supports a rollover of mobility bundles so that MaaS users can use remaining credit anytime, avoiding unnecessary travel to use up the remaining credit which otherwise would expire. Further, the participants who use car and public transport have shown the most interest in MaaS solutions with captive public transport users showing the least interest, most probably due to marginal changes to their

status quo. Although the potential MaaS adopters have seen MaaS as an economic proposition compared to the private car, more than 50% of the sample stated that the private car is their first option given the convenience it offers. The study also found that the public appreciated the value of the MaaS app even though they were not ready to pay for it.

Alyavina et al. (2020) provide similar insights based on a study conducted on sustainable user behaviour considering three different cities in the UK. They found that despite a strong interest in MaaS developments, the public still looks at MaaS through the lens of car dependence. This makes the hoped-for modal shift from the private car to multi-modal services (i.e., MaaS) a challenging task. The users have seen the inability of MaaS to surpass the convenience that they enjoy from car ownership which is quite similar to the findings of Ho et al. (2020). Given the difficulty in changing people's attitudes towards sustainable modes, the authors have suggested that policymakers should continue to subsidise MaaS by promoting public transport as the backbone and developing MaaS trials as public engagement exercises.

Polydoropoulou et al. (2020) have mentioned private users (residents, visitors and tourists) and corporate clients as the key consumer groups of MaaS. Recently, there has been a shift in the focus of MaaS consumer groups towards niche markets. MaaS products aimed at tourists have been considered since the inception of the MaaS concept in Finland; however, this was halted after a few years due to international border restrictions during the COVID-19 pandemic, financial sustainability and low patronage. This idea has been revamped in the Asian context with the addition of other non-mobility services such as accommodation and food, effectively extending MaaS from a multi-modal to a multi-service offering (Leung et al., 2022). The tourism opportunities based on MaaS are being investigated in states that serve as centres for mega-scale events, such as the Olympics and the World Cups (Leung and Burke, 2021).

Among the niche user groups is students, given their tech literacy and interest in sustainable transport schemes. Furthermore, a majority of the student population could not afford to own a car. Affordability has made many students “captive users” of traditional public transport and perhaps “potential users” of future innovative transport solutions such as MaaS that are built on the fundamentals of sharing (Rahbar et al., 2022). Older but mobile individuals can be another user group to which customised MaaS solutions can be offered. For example, Mulley et al. (2020) propose to extend the role of community transport

providers to a MaaS operator or intermediary targeting older but mobile persons while continuing door-to-door services for the less mobile people.

MaaS for rural areas is of interest and seeks to complement MaaS with Demand Responsive Transport (DRT). Despite the difference in geographical setting, collaboration among stakeholders remained a key success factor for rural MaaS developments in Finland (Eckhardt et al., 2020; Eckhardt et al., 2018). The importance of collaboration between stakeholder organisations in overcoming the limitations of rural areas has also been emphasised by a study conducted in Wisconsin, USA (Liu et al., 2020). Although most of these developments are dependent on focused and visionary legislation, they also require the common will of the stakeholders. However, limited scalability has been highlighted as one of the prominent issues in regional and rural MaaS settings (Mulley et al., 2023).

The most recent literature has moved towards discussing the new spinoffs of MaaS such as Walking as a Service (WaaS) (Lyons, 2020), Electric Car Sharing as a Service (ECSaaS) (Hensher et al., 2022) and Mobility as a Feature (MaaF) (Hensher and Hietanen, 2022). This is motivated by the changes in user needs with the recent technological developments. The concept of WaaS points out the importance of including the notion of walkability in a given area and other preferable amenities to the MaaS packages. However, this inclusion is debatable because walking has its inherent characteristics such as its availability and non-commercial nature. ECSaaS suggests including electric car sharing to attract car users towards a more sustainable initiative. MaaF comes out as a possible solution to pertinent issues such as financial sustainability and patronage growth, which are financially critical when commercialising MaaS. The MaaF concept suggests bundling mobility with other established (non-mobility) services which complement mobility such as insurance, and accommodation and offers prospects for scalability.

2.2 MaaS as an Innovation

The transport system is continuously changing at a rapid phase by leveraging technological, societal and political developments. A typical transport system includes infrastructure, vehicles, energy and services as the main components. Both modern innovation and transition theories consider innovation as a joint activity that involves a number of actors with varying capabilities, interests, roles and perceptions (Twomey and Gaziulusoy, 2014). van Wee et al. (2022) define transport innovation as “new elements of a transport system that are implemented in the real world” (p. 1). In line with this definition, the new elements

which are not yet implemented are considered potential candidates for innovation. MaaS can be considered an innovation in transport service delivery which requires advancements in complementary transport infrastructure. This includes both physical infrastructure as well as digital infrastructure such as digital platforms that enable open collaboration. Further, MaaS innovates the transport landscape with new organisational models which creates a new market comprised of new users (Surakka et al., 2018). Veeneman (2022) states that over the last few years, MaaS has moved from an innovative concept to an incremental system innovation.

Accurately forecasting potential future innovations and their impacts on society is a challenging exercise. Conversely, it is important to note that the list of futile innovations is much longer than the list of successful innovations (Filarski and Mom, 2008). The literature advises innovations similar to MaaS to initiate with a niche segment and to scale up gradually with learning experience. Transitions theory suggests experiments as a key instrument to initiate fundamental system innovations such as MaaS. It emphasises the importance of using experiments as social learning opportunities that recognise the complexity of the experiments under real-world considerations (Pel, 2022).

MaaS is considered a systemic innovation as it requires multiple stakeholders in the ecosystem to integrate their capabilities to deliver MaaS (Mladenović, 2021; Surakka et al., 2018). Mladenović and Haavisto (2021) argue that the innovation trajectory of MaaS needs to tackle the issues in arriving at a common consensus among different actors in an incremental approach and highlight the importance of evolutionary transformation towards MaaS. The validity of these claims can be understood by understanding the recent developments in MaaS organisational models and the underlying ecosystems.

2.3 MaaS Organisational Models

Section 1.2 discusses about typical MaaS ecosystem and the respective stakeholders. It has also briefly introduced various organisational models for MaaS. This section further discusses the existing MaaS models with reference to their distinguishing characteristics. An increasing focus on MaaS organisational models has resulted in both operational and conceptual MaaS models, focused upon optimum ownership structures and interactions among the stakeholders in the ecosystem in pursuit of developing a collaborative environment (Meurs et al., 2020; Polydoropoulou et al., 2020; Wong et al., 2020). Following the line of regulated and deregulated MaaS models, Eckhardt and Aapaoja

(2016) has suggested several organisational models based on a study conducted in Europe under the MaaSiFie project. The study identified five key models in which two models adopt an *Open Market* (see the top layer of Figure 2.2[1]) approach where the participating Transport Service Providers (TSP) are integrated either through a MaaS operator or reseller. The third model (bottom left of Figure 2.2) has the Public Transport Authority (PTA) as the mobility broker. The remaining model is proposed under the Public-Private-Partnership (PPP) framework. The third and fourth structures are recommended for MaaS schemes which are developed in rural areas (König et al., 2016) acknowledging the difficulty in securing adequate patronage to develop financially sustainable organisational models.

International Transport Forum (ITF) in collaboration with the World Business Council for Sustainable Development (WBCSD) has conducted case specific policy analysis with the intention of mapping the trends across transport modes to navigate towards a new mobility landscape. They have suggested four MaaS service delivery models as illustrated in Figure 2.3, namely *Walled Gardens, Public MaaS, Regulated Utility MaaS* and *Mesh-y MaaS.* The *Walled Garden* model is similar to the *Open Market* model proposed by Eckhardt and Aapaoja (2016) in the sense that the commercial integrators provide the MaaS offerings to the end users in a deregulated market. *Zipster* in Singapore (discontinued in 2021) and *Whim* in Helsinki, Finland are some examples of *Walled Garden* permutation. In the *Public Maas* model, the PTA or the regulator functions at the centre of the MaaS scheme as the mobility broker (similar to the 3rd model proposed by Eckhardt and Aapaoja (2016)). The MaaS schemes in Oslo and Berlin can be highlighted as examples of *Public MaaS.* The *Regulated Utility MaaS* model assigns the regulation and control of the platform to the public authorities with the operator role being left open to private actors. Although this permutation has been tried in Sweden it has not been successful (Mulley and Nelson, 2020; Smith et al., 2020).

As suggested by its name, the *Mesh-y MaaS* model indicates that the services are provided directly to the user by the transport service providers (i.e., without the involvement of a MaaS broker). Some trials have been conducted in the Netherlands in line with these concepts under the Blockchain challenge program hosted by Sony Corporation (Mulley and Nelson, 2020). This model is empowered through the enhancements in information

[1] TSP – Transport Service Provider, MSP – Mobile Service Provider, LSP – Logistics Service Provider, SST – Social Service Transportation, PPP – Public-Private-Partnership

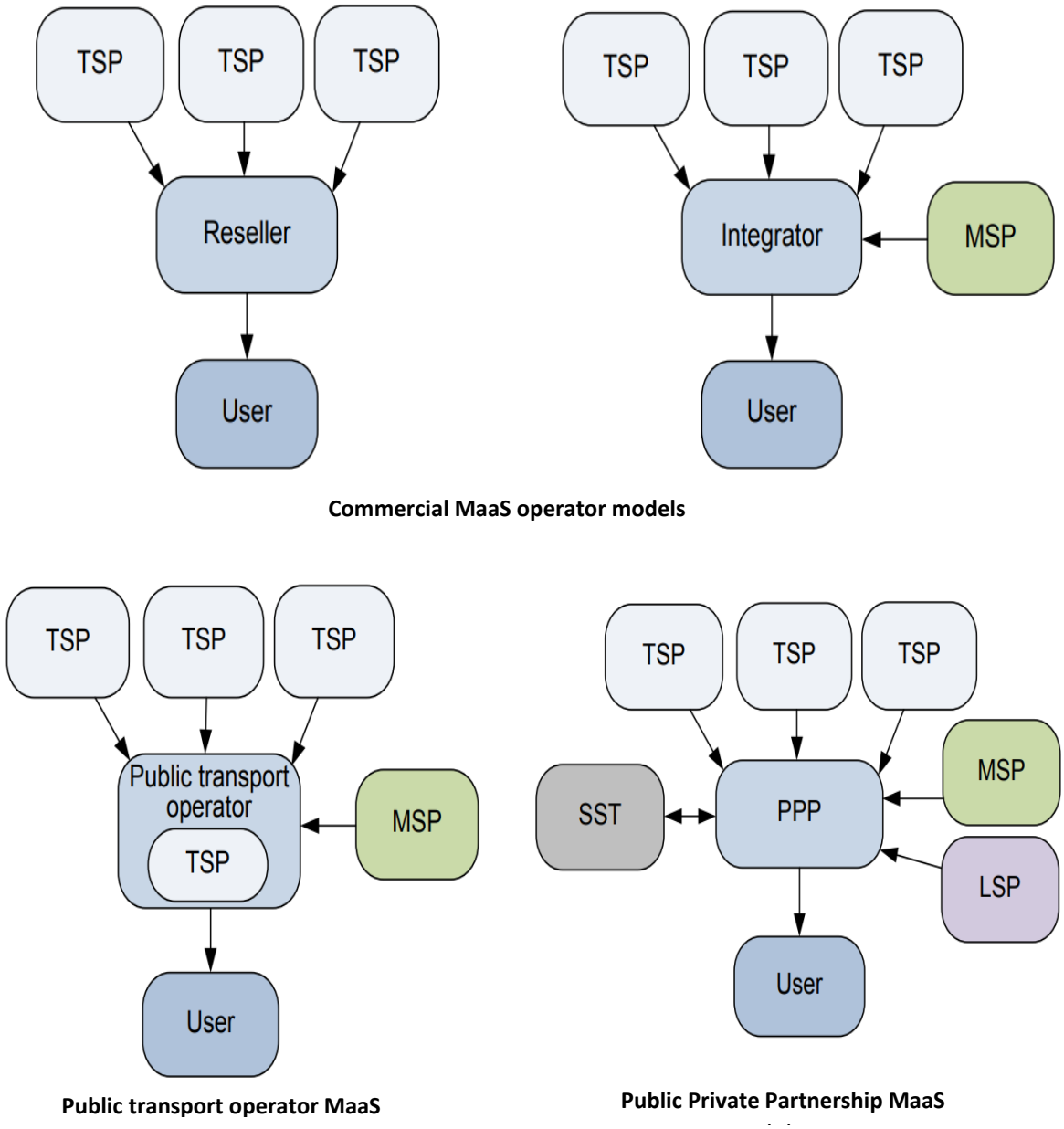

Figure 2.2: MaaS organisational models suggested in the MaaSiFie project by Eckhardt and Aapaoja (2016)

technology providing the possible options for the users from the apps developed using the data available supported by the concept of Internet of Things (IoT) (WBCSD and ITF, 2020). This is still at the conceptual level and proponents of this model suggest such a MaaS ecosystem that relies upon blockchain operations (Chinaei et al., 2022; Nguyen et al., 2019). Nguyen et al. (2019) have emphasised the ability of blockchain-based MaaS ecosystems to address the current issues related to the willingness of the TSPs to join the MaaS ecosystem via a MaaS operator by removing that layer through blockchain technology. Proponents also claim that this model can improve inter-organisational trust and transparency as it avoids the need for contracts with MaaS agents. Chinaei et al. (2022)

have further developed this model suggesting a digitally transferable ownership model for MaaS by introducing crypto-tickets that can be used between the user and TSP. Although such a model can eliminate intermediaries (i.e., the middlemen between the TSP and the end users), the potential cognitive load on the consumer (Lyons et al., 2020) (i.e., performing these functions on a day-to-day basis) is questionable.

The differences between the WBCSD and ITF models can also be viewed as different ways of allocating the roles and responsibilities to different stakeholders. The impact and the interest of the stakeholders towards MaaS vary with the service delivery model in which they operate (Meurs et al., 2020). Thus, to encourage stakeholders to join a MaaS scheme

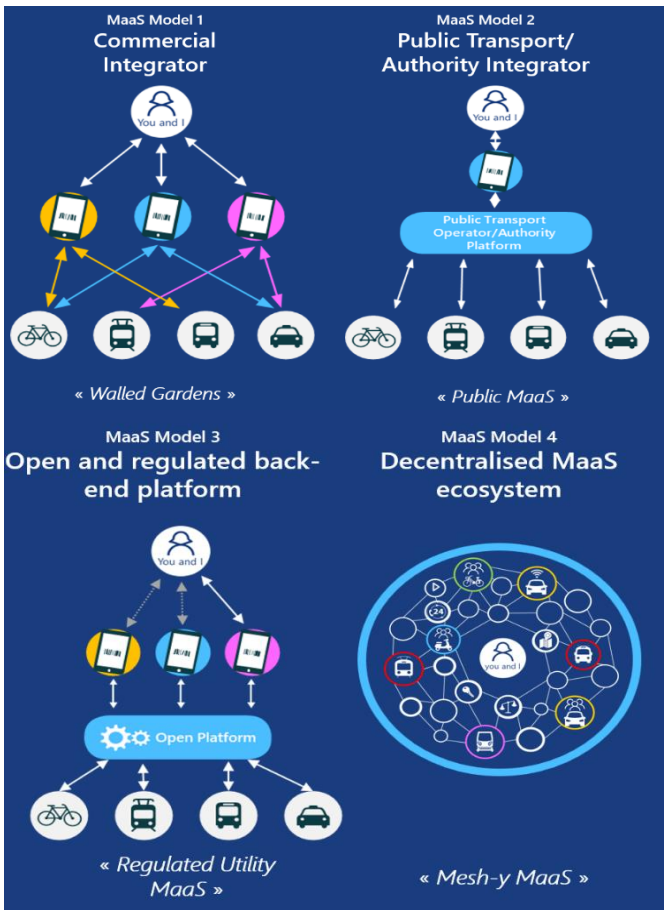

Figure 2.3: MaaS organisational models suggested by WBCSD and ITF, 2020

and perform successfully in the long run, it is important to position them in the existing transport landscape and provide them with a comparable role in the corresponding organisational model. Recognition of an intermediary referred to as a MaaS operator (or MaaS broker), who integrates the service offerings from the transport service providers and develops a bundled transport solution to end users is dominant in the extant literature on MaaS. In addition, the MaaS operator is considered the focal centre of the MaaS system as

it is interposed between the suppliers and end users. (Kostiainen and Tuominen, 2019; Smith et al., 2018b; Wong et al., 2020). The role of MaaS operator is one important focal point around which most of the MaaS schemes in the world hitherto are built although there are some broker-less models such as *Mesh-y MaaS*.

Drawing on the role of the MaaS operator, a study conducted in Sweden has evaluated the potential of introducing another intermediary between MaaS operators and Service providers known as Intermediary MaaS Integrators (IMIs). The role of IMI is to handle the administration, management and contract negotiation aspects such that the MaaS operator can be more focused on customer service (Smith et al., 2020). Although there is some interest from regulatory authorities to act as an IMI the authors favour a private actor. The key underlying reasons are the lack of innovation inherent to the public sector and the potential conflict of interest that can arise when both public and private actors compete within the MaaS ecosystem (Smith and Hensher, 2020; Wong et al., 2020).

Recently, Hensher and Hietanen (2022) coined the term *Mobility as a Feature (MaaF)* proposing mobility services to be included as an add-on (or complement) to the non-transport service offering which has already established players. The authors suggest car insurance as one service with such a potential inspired by the experience of the Sydney MaaS trial (where Insurance Australia Group (IAG) played the role of MaaS broker) and the recent partnership of MaaS Global with the Unipol (a big insurance group in Italy). It is suggested that, under the MaaF model, public transport and other mobility options be provided to car users with a marginal increment to the insurance premium. Such an offer could arguably be of interest to insurance providers who may want to earn a *'social license'* for reducing emissions and promoting shared transport. Hence the authors claim that MaaF provides solutions to the long-standing problems of MaaS, namely scalability and sustainability. However, MaaF remains a concept with no empirical or in-field test as yet. Further, this model mainly focuses on car users and does not address the transport needs of non-car users, although this could be incorporated.

With the aim of proposing an ideal framework to deliver MaaS, Hensher et al. (2023) have suggested a competitive tendering approach for MaaS drawing on the lines of MaaF. According to this framework, MaaS consortia led by MaaS operators would bid for delivering MaaS in a given jurisdiction. The tendering authority may select the winner based on the multi-modal and multi-service aspects suitable for a given jurisdiction.

Further, the authors suggest that the tendering authority can develop key performance indicators (KPI) aligned with societal objectives to reward the MaaS consortium and the respective subscribers. Although this framework has the potential to address key contemporary issues with current MaaS models, this is yet to be tested empirically. Further, the design and implementation of this model depend on contextual factors such as the availability of suitable partners and the willingness of the public sector to act as the tendering authority.

Despite these developments, there are some contrasting arguments in the recent literature that challenge the MaaS broker model drawing examples from the airline industry (Merkert et al., 2020; Meurs et al., 2020). Proponents of the broker-less MaaS model suggest a similar approach taken by the International Air Transport Association (IATA), which is an international regulatory agency establishing common standards for commercial transactions and cooperation aimed at making air travel more integrated. This regulatory agency acts as a facilitator in creating a level playing field through the provision of globally applicable solutions where the TSPs can collaborate with each other while securing their commercial interests. Another notable feature in this model is the ability of the TSPs to maintain a direct relationship with the customers. This reduces the fear of TSPs losing the link with the customer, unlike other models which introduce an intermediary between the customer and TSP. The model is assumed to be operated as *Software/Platform as a Service (SaaS)* combined with the proposition *Collaboration as a Service (CaaS)* resulting in "$MaaS_{2.0}$" = SaaS + CaaS (Merkert et al., 2020).

However, considerations need to be given to the differences between land and air transportation when mapping this to MaaS. TSPs involved in MaaS are focused on providing mass transportation within a city or adjacent areas compared to air transport networks which are usually operated as longer distance pre-planned journeys tailored to customer requirements. Moreover, a MaaS solution is built upon several modes which are distinct in terms of revenue and cost structures, governance goals and objectives whereas the airline operations are involved in a more homogeneous context given the unimodal nature of airline operations. The nature of the stakeholders involved in the context is another determinant which differentiates the two sectors. In the case of aviation, the key stakeholders would be the airline operators who provide the services and IATA which acts as the international regulatory agency (Merkert et al., 2020). Moreover, the service provided by the airline operators is mostly homogeneous in terms of cost, time, service

provision and convenience, hence making a level playing field for most operators to cooperate with each other. Whilst the rules are not mandated, the power, and authority that IATA has made it de facto mandatory for airline operators to interact with other carriers. In contrast, land-based TSPs within the MaaS model are different in terms of cost, time, frequency, and convenience in their service provision creating imbalances of power among the operators. Inherent differences in the choice of people for favouring one mode over the add-on to these imbalances. Further, the majority of land transport users have the affordability to own their transport asset (i.e., the private car) which enables them to fulfil their needs conveniently. The above considerations challenge the validity of the propositions to build '$MaaS_{2.0}$' without acknowledging such differences.

Conversely, given the existence of MaaS trials and ongoing operations, it is important to consider the validity of the above model pertaining to the real-world MaaS organisational models. The most prominent MaaS trials and schemes conducted to date operate with a broker-centric model including Whim in Finland, UbiGo and EC2B in Sweden and the Sydney MaaS trial in Australia (Hensher et al., 2020; Karlsson et al., 2020). However, only Whim and Jelbi are successful in extending their trials to long-term implementation (Hensher et al., 2020) and yet, in terms of volume as of 2022, Whim operated only 20 million (MaaS Global, 2023) trips compared to 370 million trips provided by the Helsinki public transport agency. Although there is no information about the ridership of Jelbi, it has around 55,000 registered users compared to the 3.5 million residents in Berlin (Trafi, 2020).

Proponents of the broker-less model argue that the broker-centric model is unable to create a cooperative environment and this is the underlying reason behind the stagnated growth of the MaaS (Merkert et al., 2020). On the other hand given that all the MaaS trials and operations thus far are limited to the scale and short time frame (Hensher et al., 2020) it may be too early to measure the success of the broker centric MaaS models given that the MaaS organisational models are still in their infancy. Understanding the means of transforming MaaS from niche to mainstream is one of the major challenges in the face of the industry. Further research is needed to understand the successful progression of MaaS schemes in the long run with respect to the scale and fulfilment of the societal objectives (Hensher et al., 2020; Karlsson et al., 2020; Meurs et al., 2020; Mulley and Nelson, 2020).

Rather than suggesting the best model, this study investigates the importance of stakeholder trust and collaboration in realising both short-term objectives as well as large-scale and

long-term implementation as most of these models are built on the premise of stakeholder collaboration. The need for collaboration among the partners is proposed by contemporary studies, including both grey literature (CIVITAS ECCENTRIC, 2020a; Mulley and Nelson, 2020; UCL MaaSLab, 2020) and academic literature (Hensher et al., 2020; Karlsson et al., 2016; Merkert et al., 2020; Meurs et al., 2020; Polydoropoulou et al., 2020; Smith and Hensher, 2020; Suoheimo and Lusikka, 2020). However, the development of such a collaborative environment is heavily influenced by the cultural and legislative context (Mladenović and Haavisto, 2021; Smith, 2020; Surakka et al., 2018; Veeneman, 2022). The next sub-section focuses on the suggested improvements for policy frameworks in enabling MaaS developments.

2.4 Policy Frameworks for MaaS Development

Finland and Sweden are widely recognised as the first movers who implemented MaaS in a real-world context. Several scholars have studied the development and implementation of MaaS in Sweden and Finland, particularly the policy development (Eckhardt et al., 2018; Karlsson et al., 2020; Mladenović and Haavisto, 2021; Smith et al., 2018a, 2018b, 2020; Surakka et al., 2018; Veeneman, 2022). The case study approach is popular among the studies given the importance of the roles played by contextual factors in shaping the MaaS developments. Smith et al. (2018c) highlight the availability of funding for MaaS trials by the public sector, considerations on the level of risk by key stakeholders, and uncertain market potential as key barriers that impede the development of MaaS schemes capable of achieving societal goals. Karlsson et al. (2020) have identified shared vision, legislation on transport, innovation and public administration as the key macro-level factors that impact the development and implementation of MaaS in Finland and Sweden. The meso level factors that have a significant influence include appropriate organisational models, collaborative culture and the indicative roles and responsibilities in a MaaS ecosystem.

Many studies have emphasised the need for law-making authorities to facilitate MaaS developments through appropriate regulations and policies (Hirschhorn et al., 2019; Karlsson et al., 2020; Lajas and Macário, 2020; MaaS Alliance, 2017a; Meurs et al., 2020; Mladenović and Haavisto, 2021; Smith and Hensher, 2020; Smith et al., 2018b; Surakka et al., 2018; Veeneman, 2022). The cited work highlights the importance of the government as an enabling stakeholder. Several studies have investigated the suitable policy frameworks for enabling MaaS developments (Hirschhorn et al., 2019; Lajas and Macário,

2020; Smith et al., 2018b; Surakka et al., 2018; Veeneman, 2022). Smith et al. (2018b) conducted a thorough analysis of the private and public sector collaboration based on the MaaS developments in Sweden using Open Innovation (OI) theories and suggested designing an intermediary regulatory framework that is not too demanding for the private sector to impede their participation and to be partners in innovation rather than innovation purchasers. The PTA can do this via internal innovation by absorbing the emerging roles in the MaaS arena (such as MaaS operator) or by supporting external innovation (if external actors absorb such roles). Further, the authors highlight the barriers faced by PTA when collaborating across organisational boundaries such as stringent legislation, lack of expertise, contractual complexities that arise with changes to the ecosystem, cultural stigma and absence of proper vision. By investigating the MaaS developments in Amsterdam, Birmingham and Helsinki, Hirschhorn et al. (2019) state that the public sector seeks to control the disruptive MaaS developments by reproducing the existing institutionalised ways. The authors identify six different governance approaches to MaaS namely, analyser, architect, convener, experimenter, lawmaker, and provider.

It is important to consider the time horizon of MaaS initiatives when developing the respective policy frameworks for MaaS. Lajas and Macário (2020) have proposed a public policy framework based on the Helsinki MaaS experience considering MaaS as a Mobility Management tool. The study suggests a two-staged approach for MaaS implementation considering the elements of "MaaS Flower Model". The first stage needs to identify the enabling conditions and core features of MaaS for selecting a suitable MaaS typology. The second stage involves designing suitable policy instruments considering the indicative stakeholder groups of the selected MaaS typology. The study highlights the importance of strategic vision at all decision levels which states the maturity level of MaaS for that jurisdiction. It further suggests that the successful implementation of MaaS relies upon the wise selection of policy instruments envisaged by the overarching vision. Meurs et al. (2020) suggest a similar approach with an exploration and an exploitation stage considering the changes needed in stakeholder composition and policy frameworks. In the exploration phase, trust, long-term commitment and willingness to share information are important. The exploitation phase focuses on more formal contracts that become important for facilitating collaboration among stakeholders with different, or sometimes conflicting, motivations, goals and governance frameworks.

Smith and Hensher (2020) have provided an integrated policy evaluation framework proposing nine innovation areas that are essential for MaaS developments. One of the key arguments of the authors is the misalignment of MaaS with the current institutional context. The proposed areas of innovation include MaaS focused terminology, objectives, rules, technologies, organisational models, modes, alternatives, partnerships and diffusion. The policies developed in each of these areas are further segregated into four categories based on the temporalty namely, strategic, tactical, operational and reflexive. The study suggests revising and refining types of innovation using findings from various contexts through identifying matches and mismatches between MaaS policy programs.

2.5 Review of the MaaS Readiness Indices

Drawing on the developments related to the MaaS organisational models and policy frameworks, the preceding sections discuss some of the necessary preconditions for MaaS developments. It is important to evaluate whether a particular location has fulfilled the necessary preconditions before planning, designing and implementing MaaS. A lack of understanding and absence of these prerequisites appeared to be the underlying reason behind the majority of the discontinued MaaS schemes. A collection of these prerequisites, or indicators, can be referred to as a MaaS Readiness Index (MRI) and is related to a specific geographical area (Goulding and Kamargianni, 2018).

This section includes both technical and non-technical literature on MRIs.The indices are summarised in Table 2.1. The most recent index was developed by Li et al. (2022) based on the recent MaaS developments in China. Another readiness index was developed by KPMG (2022) considering 10 cities in Ireland to evaluate the readiness to implement the latest government initiatives related to the implementation of MaaS schemes. This section discusses the indices developed by CIVITAS (2017), University College London (UCL) (2019), Li et al. (2022) and KPMG (2022). The UCL index is a successor of the Travel Spirit index (Goulding and Kamargianni, 2018). It is noted that MaaS Global also developed an MRI, but this was not considered for further analysis because of the unavailability of definitions, methods, and measurements.

2.5.1 CIVITAS ECCENTRIC MaaS Readiness Index

CIVITAS ECCENTRIC was a European Commission-funded demonstration project where five cities (Madrid, Stockholm, Munich, Turku and Ruse) worked together to tackle the challenges of transforming cities towards less polluted (noise and sound) and more

sustainable, liveable places (CIVITAS ECCENTRIC, 2017, 2020a). The project has recognised MaaS as a promising concept in shifting the travel behaviour of individuals towards more sustainable mobility patterns. CIVITAS ECCENTRIC developed an MRI in 2017 (CIVITAS ECCENTRIC, 2017) with the intention of measuring the local authority's readiness in the development and deployment of MaaS within a specific city. The MRI evaluates the capability of the local authorities to employ the necessary changes and respective decisions pertaining to the successful diffusion of new transport systems. One of the key objectives of the index is to serve as a checklist, ensuring that all critical aspects deemed essential prerequisites for the deployment of MaaS are considered in the planning process.

The constructs were identified mainly based on the grey literature on MaaS. Varying legislation of the countries (which differs from state to state and over time) has been identified as a factor that hinders and delays the MaaS process. As the index only encompasses the factors that the local authorities can directly influence, it has not considered the other non-mobility stakeholders who can add value to the MaaS organisational models such as insurers, data providers etc. The developers of the index have stated the need to conduct a separate study to understand the end-user needs, their willingness to pay and other attitudinal changes in designing the framework for MaaS.

CIVITAS ECCENTRIC has proposed four key dimensions, each of which has two indicators, totalling eight key indicators as illustrated in Figure 2.4. The dimensions include strategic readiness, usage of public transport by local authority officials and politicians, public transport use with shared mobility penetration and shared understanding of the transport providers and citizens. Each indicator is ranked on a 5-point Likert scale with 1 being the lowest.

Table 2.1: Summary of the available MaaS Readiness Indices

MRI	Year	Key Aspects considered	Level of Detail	Level of usage
MaaSGlobal	2016	Customer Demand, Transport Service Availability, Government and Regulatory	Definitions, methods, and measurements are not stated	Has not been used empirically
TravelSpirit	2017	Sharing of transport data and APIs, Availability of open-source software	Method and measurements are not stated	Has not been used empirically
CIVITAS ECCENTRIC	2017	Strategic Readiness, Internal Use, Shared Use, Shared Understanding	Definitions, methods, and measurements are stated.	Has been used to evaluate five cities
UCL	2018	Transport Operators openness and Data Sharing, Policy, Regulation and Legislation, Citizen Familiarity and Willingness, ICT Infrastructure, Transport services and infrastructure	Definitions, methods, and measurements are stated.	Has been used to evaluate two cities
KPMG, Ireland	2022	Shared Mobility, Micro Mobility, Electric Mobility, Public Transport and Digital and Tech Penetration	Definitions, methods, and measurements are stated	Has been used to evaluate 10 cities
Li et.al	2022	Open attitude of Transport Operators, people's willingness, ICT infrastructures, Government supporting policies and regulations, and data sharing	Definitions, methods, and measurements are stated	Has been used to evaluate Guangzhou

The MRI has been applied to the five cities Madrid, Stockholm, Munich, Turku and Ruse to understand the respective position of each city concerning the developed index. This was then presented in a pictorial manner in a cobweb diagram with spokes representing each dimension and 5 strings representing the ranking of each city in terms of their readiness for MaaS as shown in Figure 2.4. This index only provides a pictorial view of the standing of a city with respect to identified dimensions and hence is not capable of providing an aggregate score that enables easier comparisons. Also, as the indicator is not based on surveyed or public data, the ranking is subjective depending on the local authority's

perception of each level stated and the knowledge of the local authority officer who is conducting the respective study.

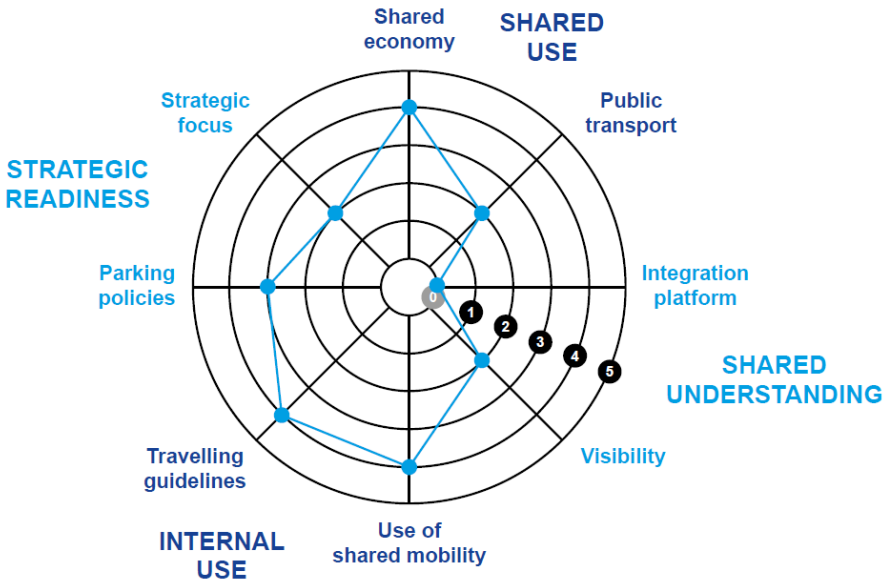

Figure 2.4: Illustration of the mapping conducted for the City of Munich, Source: MaaS Readiness Level Indicators for local authorities, CIVITAS ECCENTRIC, 2017

2.5.2 University College London MaaS Readiness Index

This index was developed by MaaSLab of University College London (UCL). The objective of this index is to measure the readiness of a city for the development and implementation of MaaS. Goulding & Kamargianni (2019) initially reviewed both technical and non-technical literature in developing the indicators which were then subjected to expert elicitation techniques to arrive at five key dimensions. The index claims that it encapsulates prerequisites for the development of MaaS and factors that lead to the successful diffusion of MaaS. However, the index does not consider the status of integration or interrelationships among the MaaS elements that exist in the current context. Further, it assumes the MaaS provider to be a private actor (Goulding and Kamargianni, 2018). Five key dimensions introduced by the model are as follows:

1. Transport Operators' Openness and Data Sharing - This includes the extent of the data shared among the transport operators and the amount of Application Program Interfaces (API) that are open, i.e., freely available to use, distribute and alter.
2. Citizen Familiarity and Willingness – This identifies the travel behaviour of the individuals in relation to the MaaS concept emphasizing the technological literacy of citizens and the use of shared transport modes.
3. Policy, Regulation and Legislation – This indicates how much the existing policies, regulations and legislations are supporting the execution and diffusion of MaaS.

4. Transport Services and Infrastructure – This verifies the potential of the existing transport system to provide MaaS. The number of modes, frequency, density and integration among them are considered.
5. ICT infrastructure – This is the presence of MaaS enabling technologies, specifically internet access and smart ticketing infrastructure.

Each of these indicators was divided into sub-dimensions, some with secondary sub-dimensions to improve comprehensiveness. This MRI was applied to two conurbations, namely London and West Midlands where London scored higher than West Midlands (0.64 vs 0.59 as the overall score or the summation of all the sub-dimensional scores). Accordingly, the city of London is considered more "ready" than the West Midlands in meeting the preconditions required to deliver MaaS. Nevertheless, Londoners have not seen much progress with MaaS development (ITS International, 2017). By contrast, West Midlands conducted the UK's first (limited) MaaS trial in 2017 through an MOU between TfWM and MaaS Global (developer of Whim); however, the West Midlands MaaS trial has not been extended towards a full-scale implementation as evidenced by the plans of Transport for West Midlands (TfWM) which has been focused on launching a new travel planning app and payment app separately (TfWM, 2021).

2.5.3 KPMG index (2022)

This MRI was developed following the National Sustainable Mobility Policy (NSMP) published by the Department of Transport (DoT) which envisions MaaS in Ireland (KPMG, 2022). The index was used to assess the readiness of 10 cities[2] in Ireland. The index was intended to assist the local authorities in understanding the development areas and the private sector to identify the potential areas that they should penetrate and focus their investments.

The index has categorised the individual metrics identified from different sources into five pillars and subsequently these were categorised into sub-pillars with a weight for each sub-area.

1. Shared Mobility
2. Micro Mobility

[2] The 10 cities include Dublin, Belfast, Galway, Cork, Limerick, Derry, Lisburn, Bangor, Waterford and Craigavon (including Portadown and Lurgan).

3. Electric Mobility
4. Public Transport
5. Digital Penetration

The city of Dublin scored the highest followed by Belfast and Cork. KPMG has acknowledged that the accuracy of the results of the index is limited due to a lack of comparable data and that the key purpose is to initiate the discussion rather than to provide a comprehensive and accurate ranking. Further, there is a lack of detail on how the scoring has been done for areas such as policy and assessing future potential.

2.5.4 MaaS Maturity Index - China (2022)

MaaS development and improvements in China have shown rapid progress over the last couple of years. The index developed by Li et al. (2022) is based on the existing academic literature and has utilised the insights provided by indexes such as UCL and CIVITAS ECCENTRIC. Consequently, the index has been customised considering the urban developments in Chinese cities. The index includes the following areas.

1. Transport operator's open attitude
2. People’s willingness for MaaS
3. ICT infrastructures
4. Government-supporting policies and regulations
5. Data sharing

The maturity index was developed for the Guangzhou area based on the National Development Strategy of the Guangdong-Hong Kong-Macao Greater Bay Area. The results have indicated insufficient readiness of the Chinese cities for implementing MaaS. However in-depth investigation of this readiness index was infeasible due to accessibility issues of the original document.

2.5.5 Critique of the MaaS Readiness Indices

While some of the MRI studies reviewed above appear to be dated in the fast-growing MaaS literature, these studies could be indeed considered pioneering. Recent studies have been conducted on building or extending the indices in relation to recent developments. The contemporary trend in this line of research focuses more on developing suitable organisational models, accounting for the structure of stakeholder relationships and the contextual settings (CIVITAS ECCENTRIC, 2020a; Polydoropoulou et al., 2020; UCL

MaaSLab, 2020). However, these indices, if modified to address the limitations (discussed below), would help immensely for the respective decision-makers in identifying the standpoint of prerequisites which are essential for the implementation and diffusion of successful MaaS systems. Hence, it would be beneficial to understand the underlying reasons for the deviation in the focus in the MaaS literature from MRI to organisational models. Further, this helps to reveal the knowledge gaps that should be considered in future MaaS developments. The following critique considers the aspects such as comprehensiveness, and consideration of crucial issues including trust, commitment and collaboration, informed by the extant literature on the design and implementation of MaaS.

1. Comprehensiveness

All MRIs have captured important aspects related to the readiness of MaaS, although UCL and KMPG indexes have some inadequacy in covering the area relating to policy and legislation. The main emphasis was given to policies and regulations relating to information sharing and open data. While data sharing is certainly important, it is hardly the only strategic policy a city may need for a successful deployment of MaaS (Hensher et al., 2020; Smith and Hensher, 2020). Other important strategic focuses may include parking policies and initiatives that promote sustainable choices and integration protocols. The exclusion of these strategic focuses in the UCL MRI may explain why West Midlands, despite having a lower MRI score than London, has been able to implement a MaaS product in partnership with MaaS Global while London is still struggling to introduce a MaaS solution. The only aspect which differentiates West Midlands from London is the policies and legislation. Inherently, the CIVITAS ECCENTRIC index is limited in inclusiveness as it only focuses on the readiness of the local authorities but not the other aspects such as the readiness of the key actors, transport infrastructure and open data. Even though the CIVITAS ECCENTRIC index has captured most of the legislative aspects it has omitted the aspects such as ICT infrastructure and data sharing which are identified as necessities for smooth diffusion and deployment of MaaS.

2. Level of Integration

The achievable level of integration between transport systems within the MaaS offer is a critical success factor for any MaaS scheme. Sochor et. al (2018) developed the initial topology for MaaS levels of integration by introducing five levels of integration based on how information, payment, ticketing, bundling and societal goals are structured in a particular MaaS scheme. Lyons et al. (2020) proposed another topology on integration with six levels considering the extent to which a typical journey performed through a MaaS solution is seamlessly integrated into providing an end-to-end solution considering both modal and spatial coverage integration. Lyons et al. (2020) further state that at higher levels of integration, the cognitive effort that needs to be employed by a user becomes minimal which may in turn result in increasing the propensity of the consumers to use the MaaS solution given the higher utility (Lyons et al., 2020). Figure 2.5 provides a visual illustration of the respective integration schemes. A more detailed comparison between these two models is presented by Hensher et al. (2020) highlighting the importance of considering the level of integration using both perspectives.

Some other studies have also acknowledged the importance of integration of the existing transport systems in the physical, network, information and institutional aspects for the smooth deployment of MaaS (Karlsson et al., 2020; Merkert et al., 2020). Except for institutional and physical integration, the UCL MaaS index has addressed the remaining

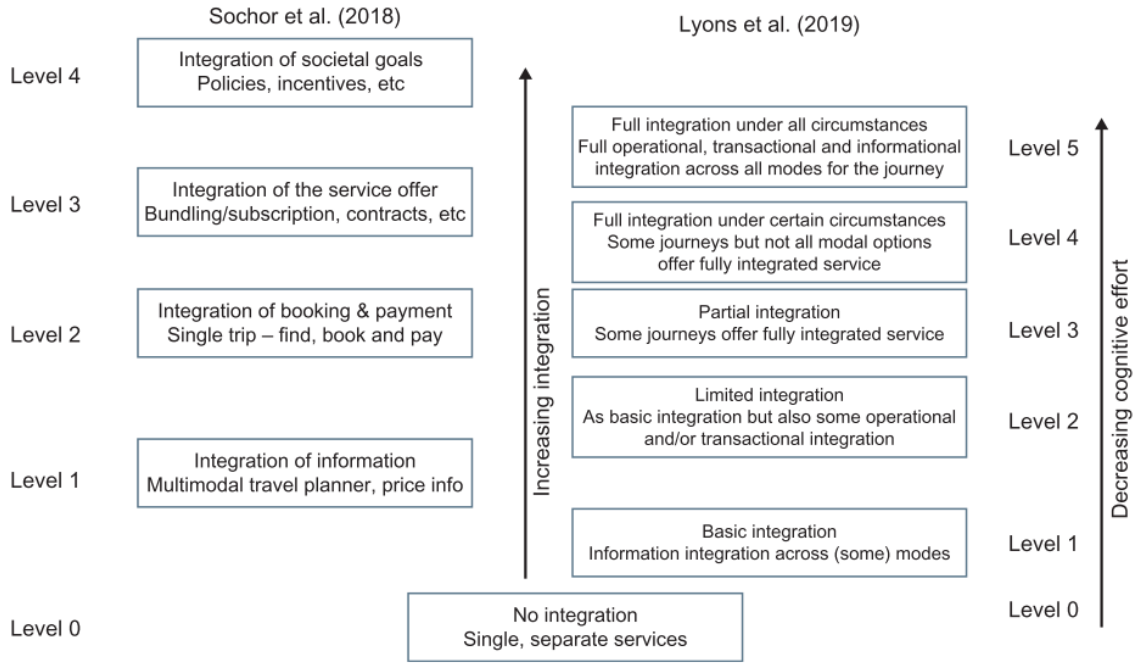

Figure 2.5: An illustration of the level of Levels of integration proposed by Sochor et al. (2018) and Lyons et al. (2019) provided in Understanding Mobility as a Service (MaaS): Past, Present and Future by Hensher et al. (2020)

aspects namely, network and information integration in detail. Although a notable effort is evident in incorporating network integration under transport services and infrastructure, the interoperability of the services is not covered adequately. The CIVITAS ECCENTRIC and KMPG indexes appear to cover only the information integration omitting network, physical and institutional aspects. Institutional barriers are among the key challenges which impede the formulation of collaborative MaaS ecosystems as emphasized by the extant literature (Karlsson et al., 2020; Meurs et al., 2020; Polydoropoulou et al., 2020; Smith et al., 2018b). Hence, the existing level of institutional integration or the plausibility of institutional integration among the actors needs to be considered as a key determinant when evaluating the readiness of a city to adopt MaaS.

3. User Acceptance

MaaS needs to add value to the user compared to their traditional mechanisms of travelling to attract users. Only the UCL and KPMG indexes address user acceptance even though it is limited only to examining the digital literacy and consumption required to become a MaaS consumer. However, the research studies conducted on user perspectives depict factors such as price and service offerings, attitudes, Transport Quality of Life (TQoL) features and demographic characteristics of the customer base as important determinants of user acceptance (Ho et al., 2021b; Ho, 2021; Kostiainen and Tuominen, 2019; Sochor et al., 2016). Further studies have shown the importance of considering the willingness of the consumers to shift towards bundled packages offered through MaaS compared to the mode-specific offerings which is an essential aspect to be considered before developing the MaaS solution (Ho et al., 2020).

4. Business Viability

The capability of developing sustainable organisational models is a necessity for MaaS to propagate successfully. This needs to address different aspects such as scalability (the ability of the model to extend geographical, financial and capacity restrictions), interests of different stakeholders in extending to non-mobility service providers such as banks and insurance companies, other tech enterprises and entertainment-related companies, government subsidy schemes, citizens willingness to pay and the attitudes of the people to accept this as an alternative to the private car (Arias-Molinares and García-Palomares, 2020; Smith and Hensher, 2020). In addition, the possibility of entering into mutually beneficial contracts among the stakeholders is dependent on numerous factors such as

conducive legislation, the commercial interests of the actors and the trust between the partners. Market size and the business potential of the actors participating in MaaS need to be considered in developing customized solutions pertaining to the context in which MaaS operates (Kostiainen and Tuominen, 2019; Polydoropoulou et al., 2020; Smith et al., 2018b). The adequacy of the MRIs reviewed in addressing these aspects appeared to be insufficient given the limited number of indicators which are focused on business viability. In addition, the lessons learnt from trials have shown that the ability of MaaS is limited in changing the travel behaviour and hence MaaS needs to be complemented by regulations on land use policies such as congestion charging, parking norms and road space allocation which can reduce the relative attractiveness of car use (Hensher et al., 2020, p. 70).

5. Trust and Collaboration between stakeholders

None of the indexes has focused adequately on trust and collaboration although KPMG has stated the importance of multi-stakeholder collaboration as a concluding remark. MaaS, promoted as a service that addresses the dynamic and complex mobility needs of everyday travellers, demands sophisticated technology, innovation, and flexibility in delivering an intuitive and economical solution. As the development of a MaaS ecosystem is a process that is intentional and contingent, it necessitates the development and realisation of fresh ideas challenging the conventional wisdom. To build trust and collaboration in such an environment, it is vital to understand the key actors in the system and their interests in joining the MaaS initiative which is found to vary among the stakeholders.

Trust and collaboration among the stakeholders in the ecosystem is found to be a critical factor for successful proliferation of MaaS, as collaborative innovation plays a vital role in developing dynamic, flexible and technology-driven MaaS solutions (Jittrapirom et al., 2017; Kostiainen and Tuominen, 2019; Meurs et al., 2020; Smith and Hensher, 2020; Smith et al., 2018b). The key barriers highlighted in the MaaS literature as hindering the development of MaaS such as institutional barriers, unavailability of open and standardized data, and issues regarding the direct ownership of the consumer can be managed to a greater extent through establishing inter-organizational trust among the stakeholders leading towards the formation of a collaborative environment. This is evident by the final report of the CIVITAS ECCENTRIC project which highlights the need for new ways of thinking and cooperation between the companies as a necessity for MaaS. Further, they highlight the need for cities to focus on adequate resources and skills that are required for multi-level

stakeholder engagement as a success factor for MaaS implementation which aligns with the remarks made by KPMG (CIVITAS ECCENTRIC, 2020a; KPMG, 2022).

However, very few studies in the literature explicitly investigate the factors that would lead to trust and collaboration in MaaS ecosystems. Yet, as evidenced by the above discussion, both industry and academic literature have pinpointed trust and collaboration as fundamental pillars on which the sustainable and long continuing MaaS schemes should be constructed. The rest of this literature review centres on the concepts of trust and collaboration, discussing findings from studies that underscore the significance of trust and collaboration in MaaS developments.

2.6 Trust and Collaboration in Inter-Organisational Relationships

This section discusses the concepts of trust and collaboration in the context of interorganisational relationships focusing more on some dominant theories in trust and collaboration in general. Although the methodology used in this research, the Constructivist Grounded Theory Method (CGTM) (refer to Section 3.2.1) does not advocate firm allegiance to any specific theory, this review was conducted to define and clarify the key terms that are discussed throughout this thesis.

2.6.1 Collaboration in an Inter-Organisational Context

The contemporary governance literature pinpoints a paradigm shift in the ways that organisations and individuals work with each other in delivering public value. Agranoff and McGuire (2003) and O'Leary and Bingham (2009) argue that the reliance on hierarchy and the silo problem-solving mentalities, which were also noted as the two of the key challenges which hinder the development of MaaS (Kostiainen and Tuominen, 2019; Smith et al., 2018b), are proven to be no longer successful in providing solutions for the societal problems that span across boundaries and jurisdictions. This creates the need for new approaches to governance arrangements such as boundary-spanning leadership and collaboration (Linden, 2010; Salamon, 2002). In the present context where network economies have become the emerging economic order in the information society, businesses such as MaaS require collaboration or a more advanced form of it, namely co-creation (Kucharska, 2017).

Definitive work on MaaS is heavily associated with keywords such as digitalization, technology-driven, disruptive, demand-driven, user-centric, dynamic and flexible – all

elucidate the need for continuous innovation (Hensher et al., 2020; Karlsson et al., 2020; Meurs et al., 2020; Sochor et al., 2016). Besides, the contemporary innovation literature argues that collaboration between partners is a stimulating factor that facilitates continuous innovation (Fawcett et al., 2012). Studies have reported comparatively high failure rates in collaborative undertakings which exceed 50% including strategic alliances and joint ventures (Gulati et al., 2012). This warns of the need for proper evaluation of issues and reasons behind the failure of such initiatives.

Coordination, cooperation and collaboration are terms that often get confused and are used interchangeably in many inter-organisational relationships (Castañer and Oliveira, 2020; Gulati et al., 2012) including MaaS. Castañer and Oliveira (2020) have redefined these terms using a systematic literature review and such a differentiation would be beneficial for this research too. Coordination refers to the attitudes, behaviour and outcome of the joint determination of common goals and cooperation refers to the attitudes, behaviour and outcomes of the implementation of those agreed goals. Collaboration goes beyond the mere aggregation of cooperation and coordination to the voluntary assistance of others to achieve a common goal or private goal. This definition itself clarifies the need for collaboration in MaaS even though stakeholders would have a set of motivations and goals as individual organisations.

Collaboration can be understood as a process through which parties share information, resources, activities, and capabilities and search for solutions that go beyond their own limited vision of what is possible (Bedwell et al., 2012; Getha-Taylor et al., 2018; Gray, 1989). Building on Agranoff and McGuire (2003) and Henton et al. (2006), O'Leary et al. (2006) defined collaboration as "[w]orking across boundaries and in multi-organizational arrangements to solve problems that cannot be solved—or easily solved—by single organizations or jurisdictions. Collaboration can include the public" (p.7). A collaborative culture is considered the platform that facilitates and causes conducive relationships among the players to thrive in a specific context. Barczak et al. (2010) define collaborative culture as a "team's shared values and beliefs about the organizations' support for adaptability, open communication, and encouragement of respect, teamwork, risk-taking and diversity" (p.333) referring to López et al. (2004). Establishing such a collaborative culture needs correct evaluation of the partners' capability as well as the partners' performance (Fawcett et al., 2012).

Although the reasons for collaboration could vary depending on the intentions of the participants and the context where it occurs, there are some general assumptions on common motives such as the possibility of obtaining mutual gains, greater flexibility, effectiveness and the ability to assist each other in environmental uncertainties (Dodgson, 1993; Gray and Stites, 2013; Seitanidi, 2010). These motives may be applicable in the context of MaaS although the reasons for different participants to collaborate are not explicitly stated. However, the possibility of obtaining mutual gains and effectiveness has been highlighted as a key partner expectation by the scholars who conduct research in the area of private-public collaboration in MaaS (Smith and Hensher, 2020; Smith et al., 2018b).

2.6.2 What is Trust?

Definitions related to trust are mostly related to the perception depending on reactions that one party explicates in relation to another party. A universally accepted definition of trust is said to be elusive as different disciplines have studied trust in different contexts employing different methods (Blomqvist and Seppänen, 2003; Pautz and Wamsley, 2011). However, in the context of this research, it is beneficial to recognise the relevant theories related to trust to understand the role that it plays in the context of MaaS.

Trust is seen as a central part of human decision-making given the focus on assessing the relationships among individuals or groups of people in society (Gefen, 2013). Hence, trust is considered a complex and multi-dimensional construct which is difficult to operationalise and measure with accuracy. Some of the definitive work perceives trust as a psychological state that involves a measure of vulnerability to risk. Hence, literature related to psychology sees trust as the mindset of individuals which is represented by the individual's willingness to accept the risks in light of positive expectations from others (Colquitt et al., 2007; Gillespie and Mann, 2004; Kramer, 1999). Extending the work of Luhmann (1979), Mcallister (1995) states trust is the individual's belief in, and willingness to act based on, the words, actions, and decisions of another. Supporting this definition Lewicki and Tomlinson (2014) have proposed three components that underpin trust: an individual's chronic disposition toward trust, situational parameters, and the history of the relationship. Moore (2014) states that trust is the capacity of a person to be assured of another party's behaviour.

2.6.3 Importance of Trust for Collaboration

Trust is found to be repeatedly recognized as a foundational element that causes effective collaboration to thrive (Ansell and Gash, 2007; Bryson et al., 2015; Provan and Kenis, 2007; Thomson and Perry, 2006). In line with the idea of a collaborative network, Berasategi et al. (2011) state that "trust amongst all network agents is the cornerstone of collaboration, and therefore there is a demand to promote a collaborative culture based on fostering human relations" (p.5). In addition, Emerson and Nabatchi (2015) argued that the understanding of collaboration and building of trust needs to be focused on the relationships between individuals, groups and organisations. Edelenbos and Klijn (2007) have stated that trust "is the answer for coping with complexity in decision-making networks" (p. 26). Authors have proposed this view as all uncertainties cannot be managed through strict surveillance, hierarchical authority or contractual clauses. Pishdad-Bozorgi and Beliveau (2016) state that true collaboration occurs only when the partners respect each other and are aware that their partners may not take advantage of each other and that they can develop better solutions and results than they perform individually. These insights illustrate how trust is essential in complex networks such as MaaS which comprises of different stakeholders with varying motives.

Table 2.2 summarises the literature on the interrelationship between trust and collaboration in inter-organisational settings. Alternatively, these statements highlight the importance of other factors to enable collaboration even though trust is essential for all such factors to work in harmony. Further, even at the level of inter-organisational trust individual human interactions become important as such experience can change the level of scrutiny in the agreements between different partners. Low levels of trust are reflected by a high level of protocols and procedures related to interactions between organisations which can ultimately restrict the potential of collaboration initiatives. This makes it important to further investigate the concept of trust and the factors that enable trustworthy relationships at both individual and organisational levels.

Table 2.2: Relationship between trust and collaboration stated in the existing literature

Premise	Authors
Trust as an antecedent of collaboration (time, trust and territory)	Blomqvist (2002)
Trust has a strong influence on a collaborative culture	Barczak et al. (2010)
Collaboration is approached by focusing on communication and trust between the business actors	Kottila et al. (2008)
Trust amongst all network agents is the cornerstone of collaboration	Berasategi et al. (2011)
Trust creates a collaborative environment	Pishdad-Bozorgi and Beliveau (2016)
Inter-organizational trust leads to better inter-organizational collaboration and knowledge sharing	Chen et al. (2014)
Trust and collaborative culture have a strong, positive correlation	Kucharska (2017)

2.6.4 Importance of Inter-Organisational Trust

MaaS is a framework that necessitates the integration of different stakeholder institutions. Hence it is worthwhile to investigate the studies related to trust in the context of organisational studies. Golembiewski and McConkie (1975) have illustrated central features of trust as (a) reliance on an event, process, or person; (b) expectations about outcomes; and (c) the implication that something is being risked in expectation of a gain. Thomas (1998) asserted trust is a multifaceted and complex phenomenon that involves cognitive, emotional and behavioural components that interact with each other at individual and institutional levels. In a recent study, Klijn et al. (2010) proposed three dominant characteristics of trust, namely: vulnerability, risk, and expectations. Summarising these definitions Lamothe and Lamothe (2012) defined trust as "a range of attributes such as dependability, credibility, faithfulness, and information sharing, as well as the expectation of cooperation between exchange partners" (p. 868). These factors have also been repeatedly asserted as the barriers behind cooperation in the existing MaaS settings (Hensher et al., 2020; Karlsson et al., 2020; Kostiainen and Tuominen, 2019; Merkert et al., 2020; Meurs et al., 2020; Mulley and Nelson, 2020; Smith et al., 2018b) which symbolises the importance of trust between the stakeholders.

Public Management literature proposes that trust needs to be studied at interpersonal, inter-organisational and systems levels although these could not always be explicitly identified. The norm of reciprocity is found to be important in large inter-organisational settings where coordination is necessary for making decisions (Getha-Taylor et al., 2018). Blomqvist

(2002) has proposed a model comprised of four factors that are necessary for both interpersonal and inter-organisational trust, namely capability, goodwill, behaviour, and self-reference. Apart from other dimensions, the technological capability of the partners is one of the key factors that are necessary for MaaS schemes to integrate with each other seamlessly (Hensher et al., 2020; Wong et al., 2020). Christenen and Laegreid (2005) have demonstrated that the institutional aspects affect trust in intra-organisational settings. Some studies have also stated the possibility of having effective inter-organisational relationships in cases where partners may not fully trust each other even though they are working inside the same network (Crosby and Bryson, 2010; Getha-Taylor et al., 2018). Increased productivity and organisational commitment are recognized as key results of trust in both traditional and non-traditional organisational settings including horizontal networks (Nyhan, 2000).

Although trust is encapsulated in individuals, inter-organisational trust shifts this focus from the individual level to the organisational level where firm members agree upon shared expectations of a partner organisation through a process of sense-making (Mayer et al., 1995; Zhong et al., 2016). Thus, in the context of inter-organisational trust, the trustor becomes the focal firm, and the trustee becomes the partner firm. Relational contracts, global outsourcing, strategic alliances, joint ventures and network organisations are some developments that have necessitated the need for inter-organisational trust as a component that facilitates corporations in an increasingly dynamic, uncertain and complex environment (McEvily et al., 2003; Zhong et al., 2016). Although there is no consensus on the definitions of inter-organisational trust, two theories have become prominent based on empirical studies. One school of thought believes that trust is a psychological state where one firm is ready to be vulnerable to the other firm (Mayer et al., 1995). This view suggests that although an organisation cannot trust another organisation member of a particular organisation, it can collectively trust another organisation through interactions that may later become institutionalised. The other school of thought sees trust as a decision that one firm takes to depend on another firm (Currall and Inkpen, 2002) where trust is seen as a decision to take action rather than holding an expectation. By integrating these schools of thought about inter-organisational trust, the contemporary literature defines inter-organisational trust as trusting decisions taken by firm management teams according to the shared psychological state of the other firm (De Jong and Elfring, 2010; Naramski and Szromek, 2019; Zhong et al., 2016).

Joint decision-making becomes harder in complex inter-organisational networks given the inherent complexity, ambiguity and unpredictability. Hence trust is found to be a critical element that fosters inter-organisational cooperation (Barczak et al., 2010; Edelenbos and Klijn, 2007). In the context of MaaS, joint decision-making is necessary given the potential of generating innovative solutions for complex problems by combining the knowledge and resources of different organisations. Joint decision-making is usually hampered by institutional complexity, the unwillingness of the actors to share information (due to the fear of opportunistic behaviour by other actors) and actors trying to pursue their interests (Klijn et al., 2010; Salamon, 2002; Seitanidi, 2010).

2.6.5 What factors will facilitate Trust and Collaboration in MaaS?

The study conducted by Surakka et al. (2018) on public transport innovations including MaaS has found that most of the Finnish stakeholders are willing to cooperate given that the essential themes and the development trajectories have been discussed in the collaboration process compared to Switzerland. Such an environment has been achieved in Finland by creating a shared vision at the point of initiation of the respective MaaS projects. However, policy and legislation have been highlighted as the main barriers to technological developments by both Finnish and Swiss stakeholders who took part in the study. Furthermore, stakeholders have recognised the importance of changing their business practices towards environmentally friendly and sustainable behaviour, through sharing knowledge and learnings with each other.

Guyader et al. (2021) have found that institutional logic plays a vital role in shaping the collaboration within MaaS based on a study conducted on the LinMaaS project (A MaaS project conducted in Linköping, Sweden with 5000 users). Misalignments in the logic of stakeholders within an ecosystem have resulted in a lack of common vision and thereby failing to establish sustainable organisational models. The study identifies five such institutional logics related to MaaS namely, State logic, Market Logic, Sustainability Logic, Experimental Logic and Service Logic. The study further explains how these logics pertain to tensions in the process of collaboration when framing each stakeholder's role, establishing sustainable business models and formulating a shared vision.

Several studies have noted the ongoing struggle between transport service providers and the other suppliers in the MaaS ecosystem to find a cooperative model that works for all parties (Karlsson et al., 2020; Meurs et al., 2020). Meurs et al. (2020) have emphasized the

need to understand the diverging stakeholder interests in forming alliances in MaaS based on the interviews conducted with the stakeholders in MaaS-pilot in Nijmegen, Netherlands. The analytical framework was based on the theories of alliance formation in economic, social and business literature. Shared goals, lower risk levels, enabling public actions and trust between the stakeholders are highlighted as some crucial factors in forming a fruitful alliance. The learning experience has also been highlighted given the study was a pilot project. The complementarity of the stakeholders joining the alliance was considered important against the involvement of competing transport service providers at the initial stages of MaaS. Trust and willingness of the partners to cooperate have been evident by comparatively open agreements between the participants. However, when MaaS moves forward from the exploration phase, the authors suggest having less open agreements and more structured contracts to secure the interests of different stakeholders because at this stage commercial interests become prominent with the intention of exploiting the knowledge gathered.

Suoheimo and Lusikka (2020) have suggested using a "Mess Map" to identify the common goals of the stakeholders involved in MaaS by applying it to the Barents Region in Finland. This is a large map that enables mapping the different complexities in a certain project in consultation with the stakeholders involved. The tool is found to be effective in contexts where the participatory approach is practised, and the authors have suggested that this might fail in cases where such a culture does not exist. Gonzalez-Feliu et al. (2018) have also emphasized the need to understand the complex relationships between different stakeholders going beyond the traditional classification of private vs. public. They have emphasized the need for both informational and decisional collaboration in MaaS given the involvement of various stakeholders with diverging interests. This extends to vertical and horizontal collaboration as MaaS requires stakeholders of the same type and same level as well as complementary and at different levels.

2.7 Implications of the Review for this Study

This review started with a general introduction about MaaS considering the user needs and requirements followed by a discussion of how MaaS has innovated the transport landscape. Subsequently, the review evaluated the existing MaaS organisational models with reference to their underlying rationale and the potential challenges in realising a comprehensive MaaS ecosystem. The need for trust and collaboration emerged as a key area of concern

which hinders the formation of resilient MaaS organisational models despite the composition of stakeholders. The studies that focus on the necessary MaaS policy frameworks have reiterated the necessity of the policymakers to shift from mode-specific interventions to system-level mode-agnostic interventions facilitating collaboration among the stakeholders in the transport landscape.

Drawing on these lines, the prerequisites for MaaS have been evaluated with reference to the readiness indices developed by industry and academia. This understanding led to the investigation of key factors which are inadequately recognised by the MRIs although the extant literature justifies the importance of the same. Trust and collaboration among the stakeholders are identified as key factors essential for both the initiation and development of MaaS. This is further validated by the current work of some of the developers of the MRIs which are focused more on designing suitable organisational models that build collaborative relationships among the partner organisations. However specific studies that identify the underlying factors that result in trustworthy relationships were limited. Even though few studies have highlighted necessary policy implications, shared vision and willingness to cooperate as key factors, the relationship between these factors and other interacting variables, has not been investigated at an ecosystem level. This research gap supports the idea of identifying the factors that create trust and collaboration and examining how the identified factors interact with each other in creating a conducive environment that prospers collaboration.

Subsequently, the theories related to trust and collaboration were investigated. These identify trust as an antecedent for collaboration. Inter-organisational trust appeared to be a complex phenomenon given the complex and dynamic organisational models that are emerging in today's world. This complexity intensifies the difficulties faced by the industry when developing suitable organisational models for MaaS. The factors such as institutional complexity and information visibility which hinder inter-organisational trust have also been identified as key issues in the context of MaaS. Further, adequate consideration given to contextual factors in studying a particular phenomenon is important in formulating rational solutions. Hence, this study aims to understand the dynamics of trust and collaboration in the context of MaaS in relation to the existing MaaS developments while recognising the necessary factors that would formulate such a collaborative environment.

CHAPTER 3 METHODOLOGY

This chapter describes the methodology adopted to address the research questions formulated in Section 1.3. The chapter starts with section 3.1, illustrating the research design which consists of two phases and subsequently explains Phase I (section 3.2) and Phase II (section 3.3) of the research design. Section 3.2 and section 3.3 include a description of the underpinning rationale behind the selection of the respective methods and tools used for data collection and analysis under each phase. Section 3.4 concludes the chapter by explaining the systematic integration of results from both phases.

3.1 Research Design

The research problem and the questions formulated in section 1.3 are focused on understanding the factors that create trust and collaboration and how those factors would build a conducive environment for the development of a particular MaaS scheme. Experience suggests that MaaS practitioners would benefit from findings based on empirical evidence collected from real-world scenarios (Karlsson et al., 2020; Smith and Hensher, 2020; Smith et al., 2018a; Wong et al., 2020). Hence, attention was given to designing the study grounded on cases that represent real-world experience. The need for more interpretive understanding led to choosing a qualitative methodology complemented by a quantitative approach.

The benefit of complementing qualitative techniques with quantitative techniques is widely suggested in the methodological literature, resulting in a rise in the popularity of the mixed method approach (Bazeley and Kemp, 2011; Jick, 1979; Yeasmin and Rahman, 2012). Inspired by the comprehensiveness of the mixed method approaches, this research is designed with two main phases as illustrated in Figure 3.1. Typically, mixed-method studies commence with a quantitative phase to discern patterns and trends, followed by a qualitative phase to enhance comprehensiveness. However, it became evident that the existing knowledge regarding trust and collaboration in MaaS is too limited to initiate a quantitative phase. Hence, the decision was made to explore the area using a qualitative phase, followed by a quantitative phase to expand upon and validate the findings of the qualitative phase.

In light of this, Phase I used a qualitative approach, namely the Constructivist Grounded Theory method (CGTM) (Charmaz, 2016; Corbin and Strauss, 1990; Glaser and Strauss, 1967) to explore how stakeholders of a MaaS ecosystem would perceive the importance of trust and collaboration. This was intended to answer both research questions (RQ1 and RQ2) using the in-depth interviews conducted with the stakeholders of the selected case studies.

RQ 1: What factors would facilitate building trust and collaboration within MaaS ecosystems?

RQ2: How would these factors build trust and collaboration among the stakeholders?

Phase II uses a quantitative technique, namely Exploratory Factor Analysis (EFA), to validate and enrich the findings of Phase I. The aim is to provide quantitative evidence for the answer to RQ1. The data for Phase II was collected using a survey questionnaire distributed to MaaS practitioners globally. Subsequently, the results of the two phases are integrated by comparing and contrasting the differences and referring to the extant literature, with the aim of arriving at a meaningful conclusion.

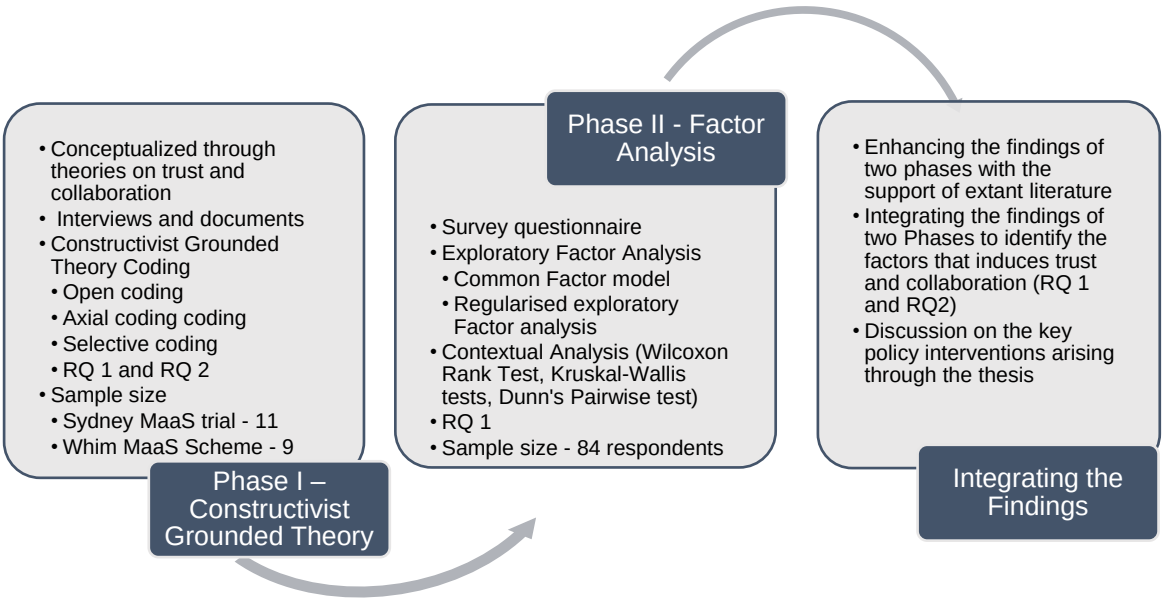

Figure 3.1: Illustration of research methodology

3.2 Phase I: Qualitative Analysis

3.2.1 Appropriateness of the Qualitative methods to understand Trust and Collaboration

Phase I of this study required a more comprehensive and interpretive understanding of how trust and collaboration formulate in MaaS ecosystems. This necessitates an in-depth understanding of the phenomenon with reference to the context of different MaaS ecosystems. Further, the experiences, beliefs and perspectives of the participants appeared to be important in understanding the conceptual formation of trust and collaboration and the influencing factors. Scholars have highlighted that such an understanding can be best obtained using qualitative research techniques (Charmaz, 2014; Corbin and Strauss, 1990; Denzin and Lincoln, 2000; Dubois and Gadde, 2014; Eisenhardt, 1989; Glaser and Strauss, 1967). Moreover, qualitative methods are found to be effective for exploratory research, particularly when there are limited studies published on the topics of interest (Myers, 2013). The need to obtain a holistic and in-depth understanding of the factors that build trust and collaboration in the context of MaaS and the limited amount of literature on this topic indicated the appropriateness of employing qualitative techniques for Phase I.

Grounded Theory Method (GTM) (Corbin and Strauss, 1990; Glaser and Strauss, 1967) is arguably one of the most prominent qualitative research approaches that can be employed when the nature of the research question is exploratory. The main aim of GTM is to develop substantial theories using systematically collected and analysed empirical data. It is used to uncover social relationships and behaviours of groups, known as social processes. GTM goes beyond “how” and “what” questions and even helps to reveal the “why” behind a phenomenon, making it useful in theory construction (Charmaz, 2017; Glaser and Strauss, 1967). Further, this makes it more attuned to the conditions under which a particular phenomenon is produced. GTM relies on empirically collected data through successive stages conducted in parallel with the analysis to compare and contrast the emerging theory and underlying themes. GTM places the researcher in a neutral observer role to allow the data to speak objectively. Although there has been an increase in the use of GTM among scholars, it has been questioned for its lack of clarity in establishing a position within the positivist and inductivist spectrum attracting increasing criticisms with the emergence of post-modernism. Constructivist Grounded Theory (CGTM) (Charmaz, 2014) was therefore developed as a response to the post-modernist criticisms emphasising the subjectivity and

importance of the reflexivity of the researcher in interpreting data taking a relativist epistemology. Hence, Phase I employed a CGTM to understand how stakeholders of a MaaS ecosystem would perceive the importance of trust and collaboration and what factors enhanced the formation of trust and collaboration focusing on real world scenarios.

CGTM is based on constructivist philosophy which denies the existence of objective reality and asserts that the realities are social constructions of the mind and hence the existence of multiple realities. Epistemologically, CGTM assumes a relativist stance, emphasizing the subjective interrelationship between the researcher and participant in co-creating the reality of a specific phenomenon (Bryant and Charmaz, 2011; Mills et al., 2006). CGTM executes an inductive approach to formulate a new theory using the data collected either through interviews, observations or focus group discussions. It highlights the importance of generating and developing the theory from data rather than being imposed with preconceived theories and ideologies. Extensive data collection and analysis is one of the limitations of CGTM due to the prolonged time frames. The challenges faced in the data collection stage of this study (specifically participant recruitment) are discussed in detail under section 3.2.2.3.

CGTM typically analyses the empirical data using three key coding stages, namely initial, focussed and theoretical coding (Charmaz, 2014; Charmaz, 2017; Chun Tie et al., 2019). The initial coding starts with raw data such as transcripts by labelling them line by line based on their underlying meaning and actions. In the focused coding stage, these will be grouped into more abstract categories based on the frequency of appearance, similar meanings or significance represented by initial codes. The theoretical coding stage involves an in-depth understanding of the meanings and relationships between the identified categories with reference to existing theories to generate overarching themes to conceptualise the theoretical framework. In practice, the researchers have either omitted some coding stages or introduced more coding stages based on the nature of the study (Chun Tie et al., 2019; Johnson, 2013).

CGTM emphasises the importance of the active involvement of the researcher in the process of developing theory through interpreting the data. It further suggests the researcher to embrace reflexivity by being aware of his/her experiences, biases and subjective perspectives (Charmaz, 2014). It is reflexive of the researcher's values, actions, situations, background and relationships with research participants. This leads researchers to be

situated in social, historical and situational parameters under which it is produced. Constantly challenging and questioning the own assumptions of the researcher is advised by the grounded theory methodologists to establish rigour (Bryant and Charmaz, 2011; Charmaz, 2014; Clarke, 2005; Corbin and Strauss, 1990).

Combining case studies with GTM is known to be more effective in scenarios that follow a process of inductive theory development (Denzin and Lincoln, 2000; Dubois and Gadde, 2014; Eisenhardt, 1989; Pan and Tan, 2011). The two main schools of case study approach are linear positivistic and non-linear non-positivistic approaches (Dubois and Gadde, 2014). The linear positivistic approach is aligned with multiple case studies aiming at replication logic (Eisenhardt, 1989; Yin, 2003). In contrast, the non-linear non-positivist approach focuses on single-case in-depth analysis to gain a comprehensive understanding (Dubois and Gadde, 2014; Dyer and Wilkins, 1991; Ragin, 1992). The overarching perspective of this study, the CGTM, suits more with the non-linear and non-positivist approach given the similarities in underlying epistemologies. Studying a suitable case in detail provides an opportunity to capture an in-depth understanding of the phenomenon recognising the effect of context-specific parameters (Dyer and Wilkins, 1991; Ragin, 1992). These developments motivated the selection of cases to gain an in-depth understanding rather than focusing on a replication logic while keeping CGTM as the overarching method for theory development. The case study approach has followed in numerous research studies conducted on the MaaS developments to propose governing principles for MaaS schemes (Smith, 2020; Smith et al., 2018b; Sochor et al., 2016; Veeneman, 2022) despite the differences in methods adopted in theory development.

3.2.2 Data Collection

The research design of Phase I consisted of five interrelated steps: literature review, case study selection, empirical work (involving expert interviews), development of an analytical framework, and development of conceptual models. The literature review, presented in Chapter 2, was conducted to understand the importance of trust and collaboration in MaaS and to identify the fundamental concepts related to trust and collaboration. The empirical work consisted of semi-structured in-depth interviews conducted with the stakeholders of the selected case studies. Section 3.2.3 describes the analytical steps used in analysing the interview transcripts. The emerging constructs and themes were examined to develop the conceptual model presented in Chapter 4.

3.2.2.1 Introduction

This section explains the rationale for the selection of case studies for this research. Subsequently, the candidate MaaS schemes were identified, and two such schemes were selected for this study, namely the *Whim MaaS scheme (WMS) – Helsinki, Finland* and the *Sydney MaaS trial (SMT) – Australia* based on the selection criteria provided in section 3.2.2.2. The selected case studies are then briefly described, with a justification for their inclusion.

3.2.2.2 Selection criteria for case studies

To select the cases for Phase I, it was necessary to adopt a definition for MaaS. Among the plethora of definitions, the contemporary description of MaaS by Hensher et al. (2021c) was used as a guideline to filter out the products that represent a mere development of apps instead of an ambitious transport solution that MaaS aims to achieve. For ease of reference, the description (or definition of MaaS) is reproduced below with key components highlighted in bold.

> *"MaaS is an integrated transport service* ***brokered by an integrator*** *through a* ***digital platform.*** *A digital platform provides* ***information, booking, ticketing, payment (as PAYG and/or subscription plans)****, and feedback that improves the travel experience. The MaaS framework can operate at any* ***spatial scale (i.e., urban or regional or global)*** *and cover any combination of* ***multi-modal and non-transport-related multi-service offerings****, including the private car and parking, whether* ***subsidised or not by the public sector****." (Hensher et al, 2021, p.153)*

Using this description of MaaS, a shortlist of MaaS products identified as potential cases for investigation in Phases I and II are listed in

From this selection process, the *WMS* MaaS scheme in Helsinki, Finland and the *SMT*, Australia were selected as suitable case studies for further investigation. The preliminary understanding regarding the cases was acquired through academic literature and grey literature which is presented in government publications, company websites and profiles. This was instrumental in helping to understand the importance of trust and collaboration within MaaS ecosystems in different contexts while understanding the barriers to the development of such a conducive environment.

Table 3.1. This list includes the MaaS schemes and trials which were in operation, or which has been discontinued as of March 2021. The case studies for in-depth investigation in Phase I are selected based on two criteria.

i) Presence of suitable case for investigation

The presence of a suitable case that is relevant to the development of trust and collaboration in a MaaS ecosystem is considered the first criterion (Eisenhardt, 1989; Glaser and Strauss, 1967; Yin, 2014). CGTM highlights the necessity for the presence of suitable phenomena in the selected cases in order to yield productive theoretical outcomes. The nature of the stakeholders involved and the presence of a situation that reveals important aspects relating to collaborative relationships are investigated using publicly available information. The majority of the cases listed in Table 3.1 possess a suitable case for investigation. However, only *WMS*, *SMT*, *UbiGo* and *NaviGoGo* had documented the process of formation of the respective ecosystems in an elaborative manner as of 2021.

ii) Access to information and familiarity

The researcher's familiarity and connection with the cases were taken into consideration in finalising the case studies, given the need of securing participants and gaining access to information that may not be explicitly available to the research (Dubois and Gadde, 2014). The access to decision-makers in the selected case studies is decisive as the data collection needs their consent and active participation. In a way, this is determined by the relationship that the researcher has with the influential decision-makers.

From this selection process, the *WMS* MaaS scheme in Helsinki, Finland and the *SMT*, Australia were selected as suitable case studies for further investigation. The preliminary understanding regarding the cases was acquired through academic literature and grey literature which is presented in government publications, company websites and profiles. This was instrumental in helping to understand the importance of trust and collaboration within MaaS ecosystems in different contexts while understanding the barriers to the development of such a conducive environment.

Table 3.1: Candidate list of selected MaaS schemes and trial

#	Name	City	Country	Trial /Product	Level of integration (Sochor et al., (2018))	Level of integration (Lyons et al., (2019))	Years of operation	Actors involved
1	Whim	Helsinki	Finland	Product	4	4	2016-present	Private actors: MaaS operator, TSPs - Car sharing, Bike sharing, Car rental, Ride-hailing Public actros: Regional Public transport authority, City council, Ministry (MaaS Global, 2023; Mladenović and Haavisto, 2021)
2	Sydney MaaS Trial	Sydney	Australia	Trial	4	4	2019-2020	Private Actors: MaaS operator, App developer, TSPs – Car sharing, Ride-hailing, Car rental, Public transport payment provider Public actors: Public transport authority, Investor/Administrator, Research coordinator (Hensher et al., 2021b)
3	Zipster	Singapore	Singapore	Product	3	4	2019-2021	Private actors – MaaS operator, Payment platform provider, TSPs – Car sharing, ride-hailing, Bike sharing Public Actors – Public Transport Operator (Abdullah, 2021; Yufeng, 2021)
4	UbiGo 2.0	Stockholm	Sweden	Trial	3	4	2019-2021	Private actors: MaaS operator, TSPs - Car sharing, Bike sharing, Ride-hailing, Car rental Public Actors: Public transport authority, Innovation Facilitator, Municipality (CIVITAS ECCENTRIC, 2020b; Sochor et al., 2016)
5	EC2B	Malmö /Lund	Sweden	Trial	3	4	2019-2021	Private actors: MaaS operator, TSPs - Car sharing, Bike sharing Public actors: Public transport authority, Municipality (Karlsson et al., 2020; Smith et al., 2022)

#	Country	City	Country	Trial/Product	Level of integration (Sochor et al. (2018))	Level of integration (Lyons et al. (2019))	Years of operation	Actors involved
6	NaviGOGO	Dundee and North East Fife	Scotland	Trial	3	4	2017-2018	Private actors: Transport technology providers, Youth organisations, a transport consultancy firm, user interface designers, algorithm specialists, TSPs – Ride-hailing, Bike sharing Public actors: Public transport authority, City council (NAVIGOGO, 2018)
7	Tuup	Turku	Finland	Product	3	4	2016-2019	Private actors: MaaS operator, Payment platform developer, TSPs - Car sharing, Bike sharing, Car rental, Ride-hailing Public Actors: Public transport authority, City council, Transport Society (Karlsson et al., 2020; König et al., 2016)
8	Jelbi	Berlin	Germany	Product	4	4	2019-present	Private Actors: MaaS operator, Mobility platform provider, TSPs: Car sharing, Bike sharing, Car rental, Ride-hailing Public Actors: Public transport authority (Trafi, 2020)
9	ZenGo	Geneva /Lausanne	Switzerland	Product	3	4	2019-2021	Private Actors: MaaS operator, App Developer, TSPs – Car sharing, bike sharing, Ride-hailing, Car rental Public Actors: Public Transport Authority (Hensher et al., 2020)
10	Amaze	Zudias, Amsterdam	Netherlands	Pilot	3	3	2019-2020	Private Actors: Mobility platform provider, Transport consultancy firm, TSPs - Car sharing, Bike sharing, Car rental, Ride-hailing Public Actors: Municipality, Ministry, Public Transport Authority (Manning, 2020)

Whim - Helsinki, Finland

WMS is considered the first commercial MaaS scheme in the world. Following a successful trial, MaaS Global commercially launched the *Whim* app in 2019 with strong support from government legislation. In addition, it includes a spectrum of stakeholders led by a commercial MaaS operator. Stakeholders include the MaaS operator (MaaS Global), private transport service providers (car and bike sharing, car rental and taxi), public transport authority (PTA) who also played the role of operator, ministry, regulatory authorities and the local municipality. As of 2019, it had 70,000 registered users accounting for 4 million trips made over the first year (RAMBOLL, 2019). MaaS Global (2023) states that the number of trips has increased to 20 million over the last couple of years. Despite these developments, integration among the transport service providers has been highlighted as a key challenge, which hampers the smooth operation and expansion of the service. This case had the prospect of revealing valuable insights on challenges and the empirical solutions formulated pertaining to trust and collaboration in developing a commercial and scalable MaaS solution.

As a starting point, it is important to understand the inception of *WMS.* There have been several regulatory reforms introduced by the Finnish Ministry of Transport and Communications (LVM) as a series of Intelligent Transport Strategies (Lajas and Macário, 2020). The first Intelligent Transport Strategy was introduced in 2009 with the aim of ensuring that people have access to well-functioning, reasonably priced transport and communication networks. In 2013, the second Intelligent Transport Strategy was published with the aim of advancing real-time information, open data and integrated payments within the transport networks. Given that the participation from the industry was inadequate the LVM subsequently joined with the Tekes MaaS team to launch a funding call to the mobility operators to develop their services aligned with the MaaS concept. This led to eight feasibility studies and several pilots (Mulley et al., 2023). In 2015, *WMS* was initiated as one of the pilots of this initiative. In 2017, the Act on Transport Service (Transport Code) was approved as the final policy milestone which is focused on improving the interoperability of mobility services focusing on integrated ticketing and open data interfaces with the improved regulatory framework. This act was entered into force in July 2018.

The *WMS* was initially launched in Helsinki and the journey was full of challenges despite the MaaS-friendly regulation introduced by LVM. This was initially due to the lack of shared vision underpinned by the communication gaps between different tiers of regulatory authorities. Even though the state government was supportive of an open MaaS ecosystem led by commercial MaaS operators they were not in favour of subsidising the system. Further, MaaS operators perceived that the PTA (HSL) had the fear of losing the ownership of their customers. The underlying reason behind this thinking is due to the plans that the City Council and HSL had to operate a *Public MaaS* positioning public transport at the heart of the solution. These conflicting interests lead to time-consuming negotiations, discouraging MaaS operators from developing their solutions and mobility operators from joining the MaaS ecosystem. At the date of writing, *WMS* operates with 13 service providers, namely Helsinki Public Transport Authority (HSL), TIER, Voi, Lime, Kaupunkipyörä, Juro, 24Rent, Toyota Rent a Car, Hertz, Sixt, Lähitaksi, Taksi Helsinki and Menevä. In line with the comments of the CEO of MaaS Global, the list is growing, and the latest successful negotiations include ferry operator JT-Lines. However, he thinks that still there is a long way for *WMS* to achieve its bigger dream of providing access at any time to anywhere (Hietanen, 2023).

Sydney MaaS Trial - Australia

MaaS in-field trials, which form a step between a design to full-scale operation are found to be vital in the process of learning and developing trust among the actors which can also serve as evidence for participants in taking risks towards scaling up the operations (Karlsson et al., 2020). The *SMT* was the first MaaS trial conducted in Australia with the involvement of key stakeholders who are required to form a typical MaaS ecosystem. This was conducted as an iMOVE CRC project and led by the Insurance Australia Group (IAG), which acted as the MaaS operator. The app was developed by SkedGo. Institute of Transport and Logistics Studies (ITLS) performed the role of research coordinator by directing the other stakeholders based on insights gained through their expertise coupled with ongoing data processing and analysis. The main aim of this trial was to enhance the understanding of the role that MaaS can play in improving the user experience and to evaluate the potential of MaaS in delivering broader societal outcomes by acting as an alternative to private car use. Sydney region possesses an extensive public transport

network and an open data platform that enables aggregating open and private data sources to generate insights to understand travel behaviour.

The trial was conducted with the participation of 93 employees in IAG for a six-month period, starting from November 2019. The mobility bundles underwent continuous changes throughout the lifecycle of the trial based on the user's travel behaviour of the previous month. The app allowed the users to compare not only the cost and time but the emissions which is a novel feature compared to the existing apps. The research coordinator, ITLS has acknowledged the use of learnings and insights from European MaaS schemes. One of the key intentions of this is to investigate further the different bundles of mode mixes and payment effects. Hence, the trial was followed by a detailed and independent analysis conducted by academics at the University of Sydney (Hensher et al., 2021a; Ho et al., 2021a; Ho et al., 2021b; Ho, 2021).

In the case of the SMT, the public sector had only a passive involvement in the project. The prevailing regulatory framework related to transport was not focusing specifically on MaaS although transport solutions related to intelligent transport systems (ITS) are encouraged. This is evident by the *Future Transport 2056*, the vision of the PTA, Transport for New South Wales (TfNSW) released in 2018. This was further emphasised in the *Future Transport Technology Roadmap 2021-2024* (TfNSW, 2021). A lack of synchronisation between service providers and passive involvement of the PTA were highlighted as key challenges in the *SMT*.

3.2.2.3 Recruiting participants

The initial understanding of the two MaaS ecosystems set a clear guide to initiate the process of the data collection process. Though the study targets a whole ecosystem approach since there are no single entities that represent the entire MaaS ecosystem, the participants were selected starting from the core stakeholder – the MaaS operator (or from another key stakeholder in the absence of a MaaS operator). Ethics approval was obtained from the University of Sydney Human Research Ethics Committee (HREC) under protocol number 2021/402. Subsequently, other stakeholders were identified, and participants were recruited for the interviews based on the principles of purposive sampling (Palinkas et al., 2015). The parallel analysis of the data assisted in identifying the areas that need further investigation and the participants were selected with the intention of bridging these gaps.

Data collection for each case commenced with a high-level interview with one or two participants from a stakeholder organisation that plays a leading role in the respective MaaS ecosystem. The main intention is to obtain a holistic viewpoint of the phenomenon and to identify the information points that the interview design should focus on to capture the important information. All the identified participants were contacted with an email, briefing them on the purpose of the project and the expected areas that are discussed in the interviews. The email was supplemented with an introductory document, participant information statement and participant consent form. Each interview was expected to run for 60 to 75 minutes.

The adequacy of the sample size is influenced by the scale of the MaaS ecosystem, and the representativeness of all key stakeholder categories. It was deemed necessary to recruit participants from each organisation to prevent potential biases that could occur due to the nature of the sampling technique (Blair, 2015; Klein and Myers, 1999). Another consideration is the level of in-depth information required and the gaps identified from previously completed interviews. The subsequent interviewees were selected based on the additional information that was deemed as required in the process of the data analysis which was conducted in parallel with data analysis. However, the ideal sample size and representativeness are restricted by the availability and willingness of the identified participants to participate in the study.

The overview interviews with the key decision-makers of the MaaS operator helped in identifying the potential interviewees. The documents published about the two MaaS schemes further assisted in extending this list. During Phase I, 21 potential interviewees for the SMT trial and 16 potential interviewees for WMS were identified and approached. Several challenges were faced during the data collection stage which are inherent to CGTM studies. Most of the potential interviewees representing TSPs were reluctant to be interviewed given the time required and confidentiality issues. Firstly, it was difficult to convince the participants to commit their time to an approximately 60-minute-long interview. This made it necessary to inform the potential participants about the value of this study in improving the MaaS products in the future. A separate introductory statement was developed for this purpose and the purposive sampling technique assisted in informing the value of the participant for this study.

Table 3.2: The final list of interviewees

Participant	Organisation	Stakeholder Category
SMT1	Institute of Transport and Logistics Studies (ITLS)	Research coordinator
SMT2	Insurance Australia Group (IAG)	MaaS operator
SMT3	SkedGo	App developer
SMT4	iMOVE	Sponsor/Administrator
SMT5	IAG	MaaS operator
SMT6	GoGet	Transport service provider
SMT7	IAG	MaaS operator
SMT8	ITLS	Research coordinator
SMT9	Transport for New South Wales (TfNSW)	Regulatory authority
SMT10	IAG	MaaS operator
SMT11	Flexicar	Transport service provider
WMS1	MaaS Global	MaaS operator
WMS2	MaaS Global	MaaS operator
WMS3	Finnish Ministry of Transport and Communications (LVM)	Regulatory authority
WMS4	Traficom	Regulatory authority
WMS5	Helsinki Public Transport Authority (HSL)	Regulatory authority
WMS6	Helsinki City Council (HCC)	Regulatory authority
WMS7	Aalto University	Research institution
WMS8	Hertz	Transport service provider
WMS9	Tier	Transport service provider

Secondly given the sensitive nature of themes such as trust and collaboration, it was necessary to build confidence about the confidentiality of the research process to facilitate open discussions in the interviews. The participant information statement and participant consent form were instrumental in building this confidence. The list of participants that were interviewed from each case study is specified in Table 3.2[3].

[3] Although the role / level of employment of each participant was considered in the process of analysis it is not revealed here to ensure anonymity. SMT refer to a participant from Sydney MaaS trial and WMS refers to a participant from Whim MaaS scheme.

The next step is scheduling the interviews. The tight schedules of the participants due to the disruptions created by the COVID-19 pandemic resulted in prolonged time frames due to limited time availability. The data collection ran for a period of 6 months from July 2021 to December 2021. At the end of Phase I, 11 interviews for the *SMT* and 9 interviews for *WMS* were conducted, covering the different stakeholders in the ecosystem. The sample size was determined based on theoretical sufficiency, the point where the emerging theory seems appropriate to explain the phenomenon under investigation (Charmaz, 2017; Glaser and Strauss, 1999; Malterud et al., 2016; Vasileiou et al., 2018). This was influenced by practicalities such as a lack of willingness to participate from some stakeholder organisations and the time frame of the study (Charmaz, 2014; Vasileiou et al., 2018).

3.2.2.4 Semi-structured interview as a research method

Interviews are the most renowned method used in qualitative research as it allows the researcher to obtain detailed ideas, views, and interpretations from the informants (Roulston, 2010; Schaefer and Alvesson, 2017; Silverman, 2013). The semi-structured in-depth interviews were conducted with the identified participants to verify their experience with MaaS, their roles and responsibilities and their thoughts on trust and collaboration. The questions were open-ended and varied with the nature of the participant's responses and the level of progression of the study. A sample interview script is provided in Appendix A. Insights gathered from the academic and grey literature and overview interviews held with the Project Lead of the SMT and the Chief Executive Officer of MaaS Global were influential in designing the questions to cover the relevant aspects. The interview questions changed as the study progressed to investigate the areas that emerged in the analysis.

The academic and grey literature on techniques for conducting qualitative studies enhanced the productivity of the interview (Myers and Newman, 2007; Roulston, 2010; Schaefer and Alvesson, 2017; Silverman, 2013). The eight guidelines of the dramaturgical model proposed by Myers and Newman (2007) for conducting qualitative interviews were used as a gliding path in the design and conduct of the interviews seeking to diminish the inherent limitations of the approach. This approach suggests considering an interview as a drama that consists of 8 components, namely a stage, props, actors, an audience, a script, an entry, an exit and the performance, which collectively affect the overall performance of the interview. The umbrella themes that governed the interviews were: the factors that build trust and collaboration in a MaaS ecosystem and how those factors build such an

environment, barriers for trust and collaboration, the importance of trust and collaboration for a conducive MaaS ecosystem and the contextual factors which facilitate building a trustworthy environment.

The participants received an email containing an introductory document, participant information statement and the participant consent form approximately two weeks before the study. The interview was scheduled upon receiving the consent form from the participants to take part in the study. The interviews were conducted either through Zoom or Microsoft Teams based on user discretion. The interviews were recorded using the same platforms and sometimes using handheld recording devices for backup purposes. The important details were noted down by the researcher as an aid to construct questions at the later phase of the interview. The interviewers were guaranteed the confidentiality and anonymity of the data to encourage authentic responses (Roulston, 2010; Silverman, 2017). Further interviewees were given the option to not answer any questions that make them uncomfortable or confidential and to opt out of the interview at any time. Otter.ai was used in transcribing the interviews. The author reviewed transcribed interviews again to ensure the accuracy of the transcripts. The transcripts were sent back to the interviewees for verification purposes.

3.2.3 Data Analysis

This section explains the procedures adopted in analysing the Phase I data. It explains the methodological steps and the decisions taken when progressing through each stage of the analysis considering the nature of the data collected and the context of the study. This section detailed how the researchers arrived at the findings discussed in Chapter 4.

3.2.3.1 Coding Method

CGTM was used to identify the theoretical insights encapsulated in the transcript data. The initial theory development started after the initial interview, drawing on the lines of theories related to MaaS ecosystems and constructs of trust and collaboration (Bryant and Charmaz, 2011; Wiesche et al., 2017). This was done with care such that the existing theories would not be imposed suppressing the emergent categories and themes.

Three coding strategies proposed in CGTM, namely *initial*, *focused* and *theoretical*, were used in analysing the data (Charmaz, 2014). The coding was conducted using the NVivo software which has customised features to assist the coding techniques (Alemu et al., 2015). In the *initial coding* stage, the transcripts were coded line by line based on the underlying meanings and actions that the selected excerpts represent. These codes were then grouped into more abstract categories in the focused coding stage. These categories were then integrated based on their interrelationships with each other searching for the overarching themes namely, trust and collaboration. In this thesis, the word "constructs" is used to refer to both categories and themes that emerged in the *focussed* and *theoretical* coding stages respectively. Each of these steps will be explained in detail in the subsequent paragraphs. The two case studies were coded separately to compare emerging constructs, themes and their interrelationships. The analysis was conducted in parallel with the interviews such that subsequent interviews could be focused more on the emerging themes and underlying theoretical directions. An overview of the coding procedure is illustrated in Figure 3.2 using some of the codes and categories that emerged in the analysis.

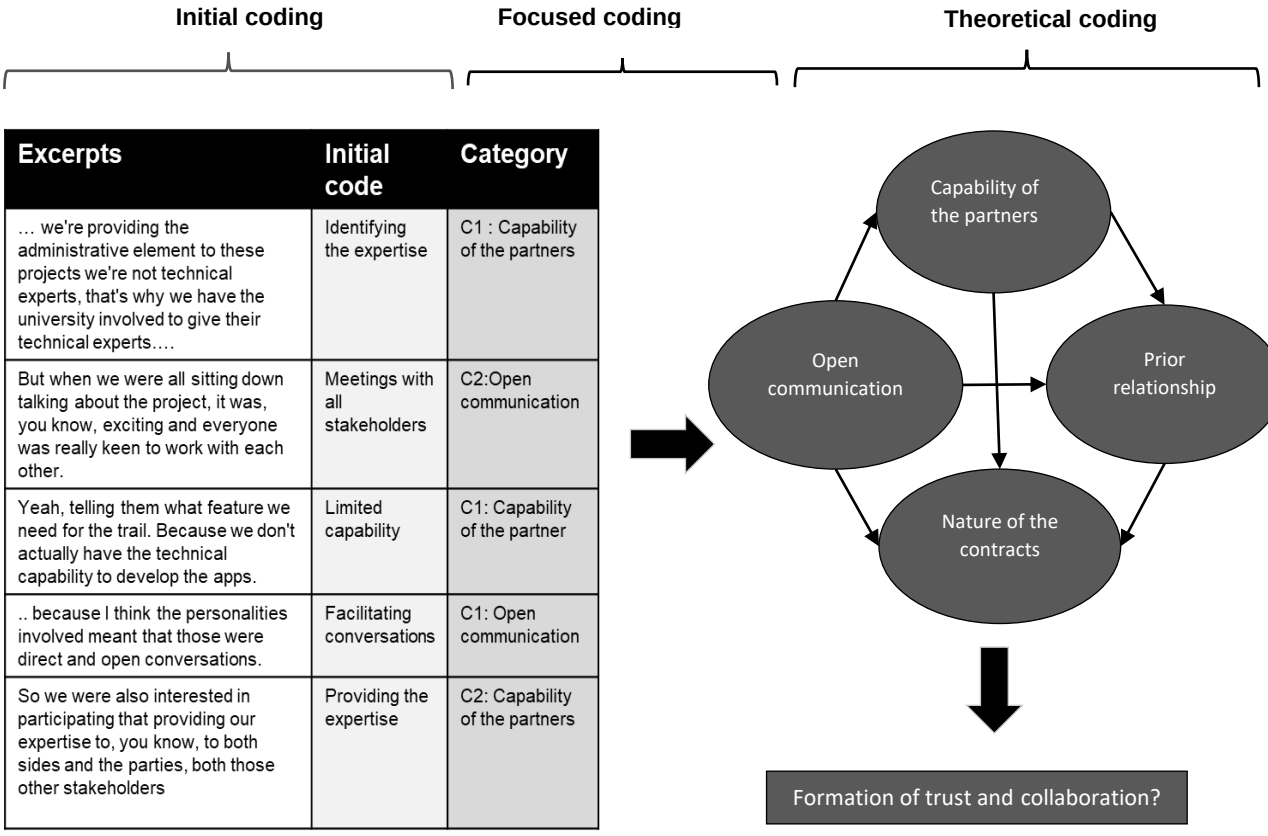

Figure 3.2: Illustration of the CGTM coding process

The *initial coding* stage involved line-by-line coding of the interview transcripts focusing on the actions and meanings of the text from the participant's perspective. When abstracting the data using initial coding the "gerunds" were preferred over "topics" and "themes". For example, "having prior relationships" was used as opposed to "prior involvement" to capture the phenomenon more reflectively. The researcher remained open to any theoretical directions emerging from the data with the intention of reducing the chance of imposing preconceived ideas on the data. The *memo writing* was conducted in parallel with the initial analysis to capture the spontaneous thoughts and ideas and to remark on the relationships between initial codes. The analytical insights gained through coding the first three interviews assisted in finetuning the research questions and sampling the new interviewees based on the emerging theoretical directions. The same codes were reutilised as the coding progressed. For example, the "stringent nature of legislation" and "exhausting rules and regulations" were aggregated into one code "having bureaucratic regulations". Figure 3.3 and Figure 3.4 provide some extracts from NVivo produced during the initial coding stage.

In the *focused* coding stage, these initial codes were further investigated to advance them to more abstract analytical levels (categories) based on the frequency or significance. For example, "having an informal relationship", "previous bad experience", and "requiring referral trust" were grouped under the category "having prior relationships". "Creating accountability", "having flexible contacts", "communicating openly" and "identifying synergies" are some of the categorical codes developed in the focused coding stage. Figure 3.5 shows a screenshot of the focussed codes generated for the *SMT*. As the interviews progressed the evidence for the codes which emerged was examined while remaining open for the new codes and to the potential of the initial codes to advance into emerging categories. The memo writing was continued in this stage to strengthen the constructs and to indicate the potential relationships. The diagramming was used to structure the categories to visualise the emerging theoretical direction. As the interviews progressed focused codes were used to sift and synthesise the data moving towards conceptualisation through the developing constructs.

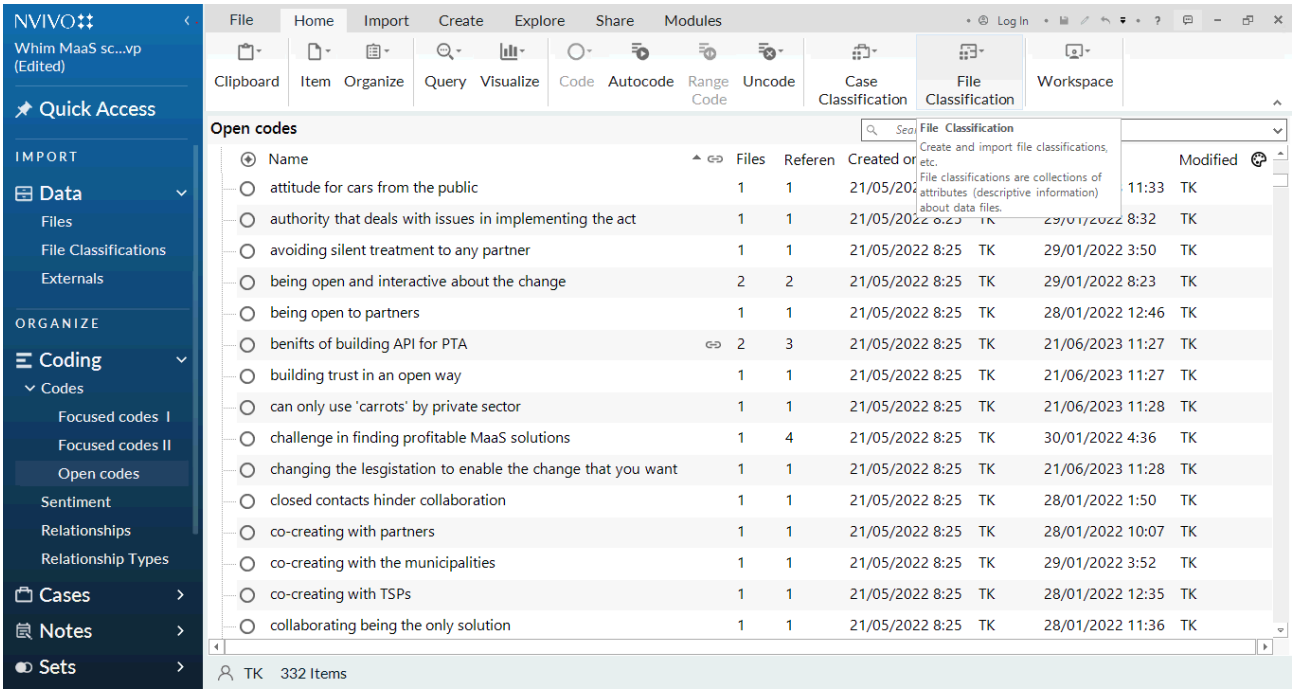

Figure 3.3: Section of open codes generated for Whim MaaS scheme

The *theoretical coding* stage was aimed at the saturation of the categories and identifying the interrelationships and interactions among the categories and emerging themes with reference to extant theories. In the latter phase given the limited time frame theoretical sufficiency is used instead of saturation given the exhaustive nature of theoretical sufficiency. The data were assigned to the most suitable category through constant comparison between the data and the emerging categories. In this process, the analysis moves from mere description to conceptualisation via understanding interrelationships

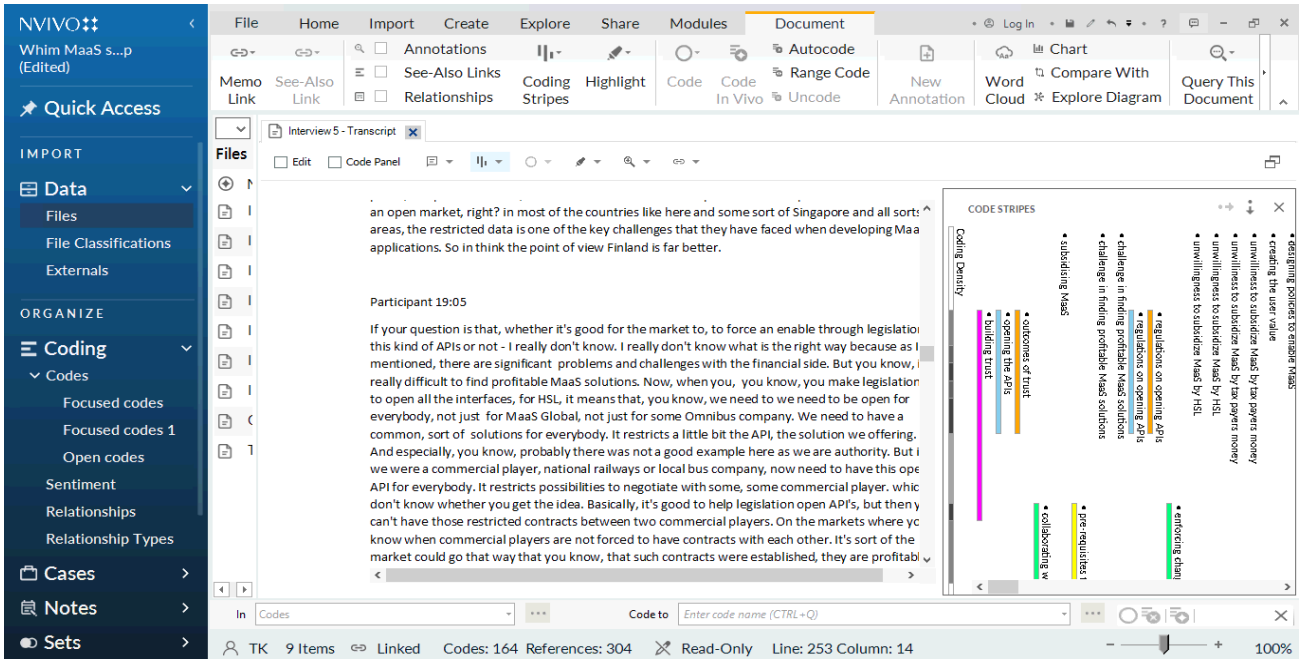

Figure 3.4: Interview transcript with the coding density

among the categories and the overarching themes: trust and collaboration (Charmaz, 2014). Subsequently, the key theories related to MaaS ecosystems were studied focusing on the insights provided on trust and collaboration. Although the researcher acquired preliminary knowledge about the constructs of trust and collaboration, firm allegiance to any specific theories was not upheld, in order to remain open-minded (Charmaz, 2014; Timmermans and Tavory, 2012; Wiesche et al., 2017). In this step, the respective theories related to trust and collaboration were also based on their relevance to the categories and themes i.e., constructs which emerged from the analysis of collected data. Insightfulness, appropriateness in the levels of analysis, and closeness to the empirical reality were the fundamental criteria for the selection of theories based on extant literature.

Subsequently, the relationship between the constructs of trust and collaboration was investigated and was grouped under factors creating trust, pre-requisite for collaboration and the outcomes of collaboration in the process of conceptualising the emerging theory. Visual diagrams and aids were used to integrate the constructs into a meaningful and representative model that explains what is happening in each case study (Chigbu, 2019; Clarke, 2005; Gioia et al., 2012). Memos were written throughout the process of analysis to denote the changes, overlaps, integrations and disintegrations of constructs (Charmaz, 2017; Chun Tie et al., 2019). The theory development was conducted continuously up until the researcher was convinced about the explanation capacity of the theoretical lens in comparison with the data collected via interviews.

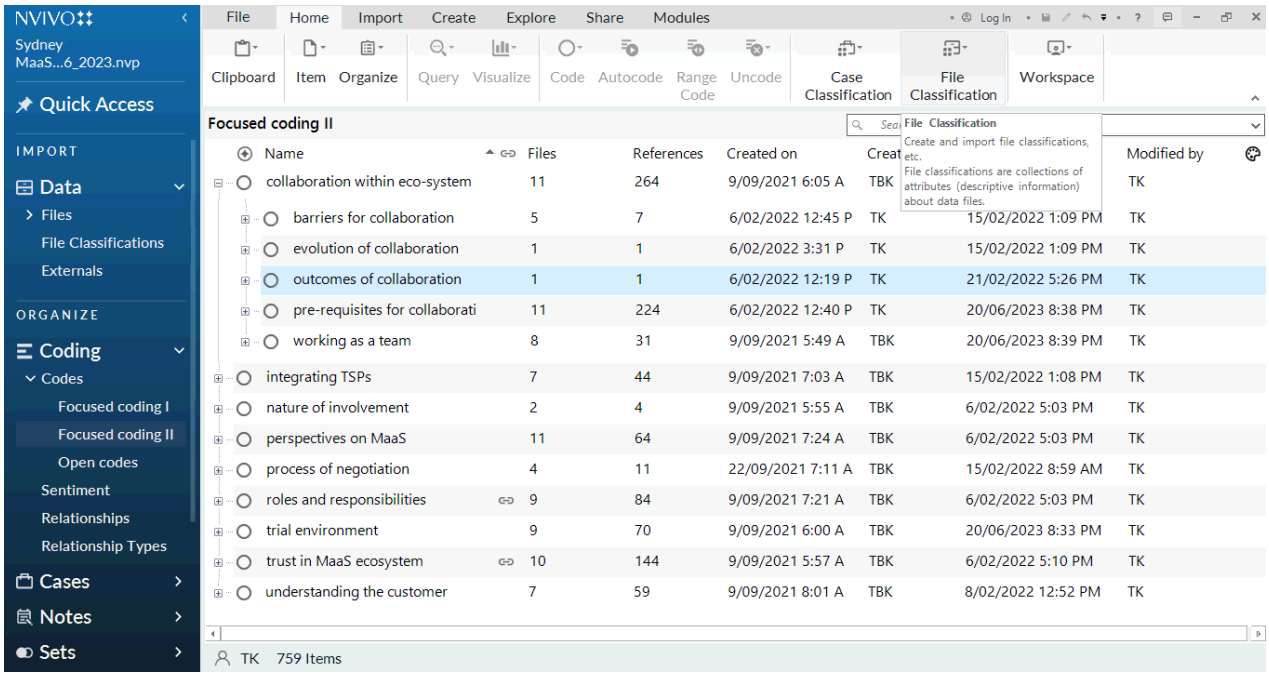

***Figure 3.5**: Section of focused codes developed for Sydney MaaS trial*

The impending models were iterated and refined a few times in parallel with the progression of the interviews and memo writing. Developed constructs were compared with the empirical reality using the developing conceptual models while cross-validating with the interview transcripts. This process is conducted until suitable theoretical constructs are established relating to the development and formation of factors related to trust and collaboration within a MaaS ecosystem. Then similarities and differences between the two models were investigated referring to the contextual differences to offer profound insights. This theoretical lens was expanded in each iteration augmenting diverse constructs and propositions related to the formation of trust and collaboration in a MaaS ecosystem. The final iterations of the two conceptual models (SMT and WMS) are presented in Chapter 4, with the constructs belonging to each model described separately. The insights generated in this phase formed the basis to develop Phase II aiming towards generalisation and holistic understanding of the phenomenon.

3.3 Phase II: Quantitative Analysis

3.3.1 The rationale for Phase II

The intention of Phase I was to identify the factors that form trust and collaboration and how these factors would form collaborative relationships within the MaaS ecosystem using two case studies, namely *WMS* and *SMT*. It was expected that the outcome would be strongly influenced by different contextual factors. It is also encouraging to find out whether there would be some fundamental constructs that need to exist in a particular context to form collaborative relationships within the MaaS ecosystem. Consequently, Phase II aimed at generalising and validating the constructs identified in Phase I using a survey distributed to the MaaS stakeholders worldwide. Thus, Phase II had the potential to improve comprehensiveness in the event of any discrepancies compared to Phase I (Jick, 1979; Williams, 2007; Yeasmin and Rahman, 2012).

The main intention of Phase II is to widen the participants to all bodies that show interest in MaaS and/or are actively involved in the development of MaaS to cover different stakeholders in the MaaS ecosystem. Hence, the data for Phase II was collected using an online survey questionnaire distributed to different stakeholders with involvement in MaaS ecosystems which satisfies (or comes closest to satisfying) the definition provided in section 3.2.2.2. This phase complements Phase I in widening and enhancing the findings to proceed with the formulation of the final theoretical framework (Bazeley and Kemp, 2011).

Further, studies like Edwards and Bagozzi (2000) highlight the importance of revealing the relationships between constructs and indicator variables as it enables unambiguous "mapping of theoretical constructs onto empirical phenomena"(p. 155). It would be beneficial to investigate whether there is a potential to identify the constructs that appeared in Phase I using the indicator variables that can be evaluated. This forms a strong synergy between the methods used in Phase I and Phase II which can be used to understand the similarities and differences and thereby generate comprehensive discussions.

3.3.2 Suitability of Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) stands out as a special case of Structural Equation Modelling as it does not need a priori assumptions or theories related to the data or variables under investigation (Ockey, 2013). Fabrigar and Wegener (2012) have stated that EFA is suitable when investigating the underlying structure of correlations among the set of observed variables with the objective of finding a more parsimonious representation. Moreover, construct identification and instrument validation are mentioned as the two key objectives of EFA where the first objective is more attuned to the aims of Phase II. The Confirmatory Factor Analysis was deemed inappropriate for this study as it needs the researcher to hypothesise the number of factors and to assume the pattern of non-zero and zero loadings of the measured variables on the common factors (Fabrigar and Wegener, 2012). The literature related to MaaS trust and collaboration was not mature enough to make strong theoretical and empirical assumptions on the number of factors and their influence.

EFA is useful when the research area is not mature enough to test how these constructs are causally related as it is mainly a data-driven approach (Aaltonen, 2017; Watkins, 2018; Williams et al., 2010). EFA can assess how many constructs a particular set of measured variables is accounting for while indicating the communality of the measured variables. This relates to the context of Phase II and the nature of the measured variables used. The measured variables used in the questionnaire (refer to Table 3.3) are identified either through the extant literature or through Phase I. The relationship of these measured variables with the constructs cannot be validated with reasonable accuracy with the available information. EFA provides information that assists in interpreting the nature of the identified factors or constructs. Previous experience suggests that using factor analysis in developing theory needs to be executed with caution as the outcome is a combination of

subjective decisions taken at each step. Further, there could be possible alternative explanations for the same dataset with equal potency, making it hard to distinguish among them (Cattell, 1978; Comrey, 1978). Thus, the researchers' familiarisation with the data and the concept of MaaS is instrumental in extracting a reflective outcome.

The fundamental use of EFA aligns with the main goal of Phase II which is to discover the latent factors behind trust and collaboration in MaaS ecosystems using identified measured variables. The existing literature on trust and collaboration on MaaS contained hypotheses about the causal relationships between some of the constructs identified in Phase I. Although the findings of Phase I are expected to generate some factors such as the capability of the partner, prior relationships, transparency, mutual understanding etc. and their interrelationships, it was decided to run Phase II independent of Phase I such that it can be objectively complemented with the findings of Phase I. Further, the influence of each measured variable on the latent factors can be determined using the factor loadings which is useful in calibrating the optimum factor structure. Hence, EFA appeared to be suitable for this study given the relatively unclear expectations of the causality of the measured variables. This consideration also becomes important in selecting an appropriate factor extraction method when using EFA.

Principal Component Analysis (PCA) and Common Factor Method (CFM) are commonly used techniques to extract the latent factors under EFA. Literature suggests that the difference between PCA and CFM can be observed when communalities are low (<0.4) and the number of measured variables (three) per factor is low (Widaman, 1993). There have been debates on the similarity between PCA and CFM. The difference is the segregation of common and unique variance. CFM is unable to perform this separation but rather illustrates the measured variable as a linear function of principal components which contains both common and unique variance. Thus, the principal components are not technically latent factors and hence it is not accurate to label them as common factors. Further, it accounts for the variance of the measured variables rather than the correlations even though it is commended for its simplicity and efficiency (Fabrigar et al., 1999). This makes CFM more suitable for Phase II as it is aimed at discovering the latent factors considering the correlations between the measured variables. Many methodologists suggest using CFM over PCA when the purpose is to discover the latent factors that account for the variance (Fabrigar et al., 1999; Ford et al., 1986; Gaskin and Happell, 2014; Izquierdo et al., 2014; Norris and Lecavalier, 2010; Price, 2017; Tucker, 1997). The CFM model

provides certain hypothesis such that the model can be rejected if is it not a good fit whereas PCA does not offer this option (McArdle, 1990; Widaman, 1993). The accuracy of CFM model is higher than the PCA when the data follows the assumptions of EFA.

3.3.3 Assumptions of EFA

The parsimonious representation is meaningful only if the number of common factors that are needed to explain the correlations among the measured variables is considerably less than the number of measured variables used. It is assumed that the non-zero correlations occur between the measured variables hence some of these variables have a linear influence from one or more of the latent constructs. Alternatively, the measured variables can measure one or more of the same latent constructs (Fabrigar and Wegener, 2012; Watkins, 2018). In this study, it is expected to observe non-zero correlations among the measured variables given the relationships among the latent constructs that have emerged in Phase I. Further, EFA assumes each measured variable to have a unique factor that explains the remaining variance that is not explained by the underlying latent factor ((Cudeck, 2000; Fabrigar and Wegener, 2012). The unique factors (specific + error) influence only a single variable and these are assumed to be unrelated to each other making them incapable of explaining the correlations among the measured variables.

The assumption of orthogonality of the common factors is commonly used in EFA although this can be discarded in certain cases when conducting factor rotation (Fabrigar and Wegener, 2012). The findings of Phase I imply that this assumption may not stand for the factors that may emerge in Phase II. The latent factors that are expected to emerge from Phase II are supposed to have complex interrelationships according to the models developed in Phase I. These considerations were taken into account when determining sampling techniques for data collection.

3.3.4 Sample size and nature

Selecting a representative sample with the population of interest is suggested over convenience sampling for EFA in many studies (Fabrigar and Wegener, 2012; Jung and Lee, 2011; Watkins, 2018). Conversely, homogeneous samples have the drawback of restricted variance and hence it is suggested to ensure the sample is well represented with the individuals who would have a diverse range of scores. This takes precedence over the representativeness of the sample given its importance in generating accurate estimates.

However, given the lack of industry practitioners in MaaS achieving both representativeness and adequate sample size was an arduous task.

The intense debate of minimum sample size for EFA still exists although there have been some improvements compared to the focal point of the debate at its origin. Initially, it was suggested to have a 5:1 or 10:1 ratio between measured variables and constructs or to have large enough samples such as 100 or 200 in order to generate close estimates of the population parameters(Cudeck, 2000; de Winter et al., 2009; Gaskin et al., 2017). The research conducted based on statistical simulations suggests that the sample size should be determined considering the relationship between measured variables and factors (factor loading), the number of factors and the number of measured variables. Minimum sample size tables provided by (Mundfrom et al., 2005) are another popular method used to determine the sample size in EFA.

Given the practical difficulties in approaching a large pool of respondents due to the nature of this study, the possibility of conducting EFA on small samples has been investigated. Hence EFA is considered a technique for large sample sizes (*N*) and most literature suggests $N = 50$ as an acceptable absolute minimum (de Winter et al., 2009). Early studies have shown that apart from the sample size, number of variables per factor (Browne, 1968; Tucker et al., 1969) and communality have a positive effect on factor recovery (Acito and Anderson, 1980; Pennell, 1968). MacCallum et al. (1999) proposed a framework for the effects of sample size on factor recovery and contended the threshold for minimum sample size. The framework suggests that the factor recovery improves as sample size increases, communalities increase and the factors per variable increase. It is also important to note that the effect of the *number of variables (p)/the number of factors (f)* decreases when the communalities increase. The simulations by MacCallum et al. (1999) and MacCallum et al. (2001) applied a minimum of N=60 although it is applicable for even lower sample sizes. Recent studies have investigated the use of EFA with sample sizes below $N = 50$ for different levels of factor loadings (λ), number of factors *(f)* and number of variables (*p*). The results indicate that EFA can yield reliable results if the data is well conditioned i.e. high (λ), low (*f*) and high (*p*) (de Winter et al., 2009).

The targeted sample size for Phase II was 100 participants, considering the above discussion. Although the number of measured variables implies the need for a much larger sample it was apparent that larger samples are unrealistic given the estimated size of the

target population. The sample selection was based on snowball and purposive sampling strategy, given the importance of representativeness and the limited number of professionals and practitioners in the MaaS arena.

3.3.5 The survey instrument development

Literature suggests designing and developing the data collection by giving thought to the method of analysis is important in cases where the data analysis follows a specific structure such as EFA (Comrey, 1978; Fabrigar and Wegener, 2012; Fabrigar et al., 1999; Watkins, 2018). Such studies further recommend careful consideration to be given when selecting the suitable measured variables in the questionnaires by referring to previous studies, theories and the empirical setting. Further suggestions include the delineation of the measured variables as comprehensively as possible in cases where the researchers have little or no basis to anticipate the number and nature of common factors (Cattell, 1978; Watkins, 2018). This study adopted the latter approach given the lack of verification as to which measured variables may fall under which common factors.

However, in such cases, the sample size does not merely depend on the measured variables. Rather, it depends on the communalities and the extent to which each common factor is overdetermined. The Phase II survey questionnaire was developed based on the constructs and the relationships identified in Phase I via the process of theory development. The utility of the measured variables as indicators of the factors is an important consideration. It is suggested to focus on content, convergent and discriminant validity when developing the measured variables (Izquierdo et al., 2014; Watkins, 2018). Most of the literature supports including three to five measured variables for each of the common factors that are expected to be extracted from the data given the effect that it has on accuracy (Browne, 1968; MacCallum et al., 1999; Velicer and Fava, 1987). These guidelines were followed when developing the survey questionnaire in order to maintain rigour in the research process.

Operationalizing trust and collaboration is one of the key challenges encountered during survey development, given the subjectivity, dynamic nature, contextual differences, and measurement issues. The qualitative phase assisted in capturing contextual differences through in-depth discussions, and the extant work on trust by authors such as Blomqvist and Seppänen (2003) and Klijn et al. (2010) aided in overcoming the complexities related to measuring trust and collaboration. The measured variables for the survey were developed considering the prominent constructs that emerged in Phase I and the variables that are

highlighted in the literature. More emphasis was given to the Phase I findings as the union of constructs identified in both cases was used to develop the survey. The measured variable was scored on a 5-point Likert scale of *1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, to 5 = Strongly Agree*. Table 3.3 includes a list of measured variables included in the questionnaire. Apart from these, the opening questions of the survey were intended to capture the demographics to identify the effect of the socio-demographic factors. These include organisation, level of employment the country of MaaS operation of the interviewee and motivations of the organisation in engaging with the MaaS scheme(s). The survey questionnaire (as it appeared in the online survey platform) is provided in Appendix B.

The survey was designed to be completed in approximately 15-20 minutes. Several iterations of the survey were developed to improve its comprehensiveness and simplicity. After the internal validation, a pilot study was conducted using 8 participants. The feedback received included the lack of clarity, confusion and the need for thorough experience in MaaS. The first two concerns were addressed by rewording the relevant questions. The need for thorough experience in MaaS is considered a strength rather than a weakness as the survey is targeted to a population who had an active engagement in the field of MaaS.

Table 3.3: Coding of the measured variables

Code	Question
	Trust related
12_1	All the terms and conditions should be explicitly stated in all contractual agreements.
12_2	Personal trust between employees is essential for inter-organizational trust.
12_3	Without trust, collaboration cannot happen.
12_4	Recommendation on a new partner from an existing partner is essential when entering into MaaS agreements.
	Nature of the partners
13_1	Organizations should consider the reputation of the partners before entering into MaaS partnerships.
13_2	Partners should have synergies in their product/service with MaaS to collaborate.
13_3	It is appropriate for partners to be involved in MaaS as a learning opportunity.
13_4	Highly capable partners can fail if they do not receive the required support from other partners.
13_5	MaaS schemes should have partners covering all stakeholder groups.
13_6	MaaS schemes that have few partners from selected stakeholder groups cannot succeed.
	Transparent communication

Code	Question
14_1	All transport service providers should be informed about the key strategic directions of the MaaS scheme.
14_2	MaaS operators should maintain frequent communication with every stakeholder.
14_3	Agreements among the partners should be visible to all stakeholders.
14_4	Data and information about the MaaS scheme should be available to all the partners.
	Shared understanding
15_1	Collaboration can still happen without having a common understanding.
15_2	All stakeholders should share a common understanding of MaaS.
15_3	Expectations management should be a regular exercise in MaaS developments.
15_4	Different partners who have different interpretations of MaaS can work together.
	Open data standards
16_1	All transport service providers should develop their APIs to be compatible with MaaS.
16_2	APIs should be both open and compatible to realize MaaS.
16_3	Open APIs are not a threat to data security.
16_4	Opening the APIs depends on the nature of other partnering organizations.
16_5	The cost of API development should be recovered from MaaS revenue.
	Prior relationships
17_1	Prior relationships are an added advantage in working with partners.
17_2	Prior commercial relationships have an edge over other prior relationships.
17_3	Understanding the partner before developing a business relationship is important.
17_4	Prior relationship with the partner is needed to build trust.
17_5	Prior relationships need to have a considerable temporal history.
	Nature of the contracts
18_1	Open market ecosystems without government intervention work best for MaaS developments.
18_2	MaaS contracts must be flexible to accommodate changes.
18_3	Contracts create accountability.
18_4	Clearly defined roles and responsibilities for a partner improve their accountability.
	Regulatory enforcement
19_1	Regulatory authorities should set the vision for MaaS.
19_2	Regulation should set open data standards.
19_3	Regulation should enforce open data standards.
19_4	Regulation should enforce fair contracts.
19_5	Regulatory Authorities should enable MaaS developments.
19_6	Regulatory authorities should have a passive involvement in MaaS.
	TSPs motives
20_1	TSPs should open up their APIs to realise MaaS.
20_2	Increasing volume is the main motive of TSPs.
20_3	MaaS is an effective sales channel.
20_4	Investing to develop a good API would be beneficial when joining MaaS.

Code	Question
20_5	TSP must provide discounts as a condition of joining MaaS.
20_6	MaaS objectives should align with the organizational motives of TSPs.
	Involvement of PTA
21_1	PTA should regulate the MaaS developments.
21_2	PTA should be the MaaS operator.
21_3	PTA should be actively involved in MaaS development.
21_4	PTA can enable public transport as the backbone of MaaS offers.
21_5	The involvement of PTA retards the Maas developments.
21_6	If PTA runs MaaS it creates more confidence among stakeholders.
	Coopetition
22_1	MaaS itself is a result of collaboration.
22_2	There should be synergies between partners to collaborate with each other.
22_3	Competing TSPs could collaborate on the same platform.
22_4	Collaborating with competitors can be beneficial.
22_5	Collaboration would allow firms to go beyond the contractual obligations.
	Focus on societal motives
23_1	The main aim of MaaS is societal motives.
23_2	Societal motives should stay on top of commercial motives.
23_3	The government needs to subsidise the MaaS developments considering the societal goals that it delivers.
23_4	Societal benefits of MaaS must be measurable.
	Nature of the organisational model
24_1	MaaS is still in the stage of development.
24_2	MaaS should be operated by a commercial entity.
24_3	MaaS can stand alone as a commercially viable solution.
24_4	Government should subsidise MaaS in return for the societal benefits it receives.
24_5	MaaS is on the correct innovation trajectory.
24_6	Blockchain technology based MaaS system (where TSPs have direct contracts with users - no intermediary) could solve trust issues in MaaS.
	Understanding the motives
25_1	Partners should be aware of the motives of other partners.
25_2	Commercial motives need to be prioritized if that's what the partners need.
25_3	Some partners may be dominant given their roles in the ecosystem.
25_4	Partners should know each other's capabilities before joining the ecosystem.
25_5	Identifying synergies creates win-win solutions.
25_6	Open negotiations lead to win-win solutions.
	Need for a MaaS champion
26_1	Collaboration in MaaS needs a leading organization.

Code	Question
26_2	There should be an organisation that connects all stakeholders together.
26_3	MaaS operator needs to lead the MaaS schemes.
26_4	Some stakeholders are better at leading MaaS solutions given their role and exposure.
	Identifying conflicts
27_1	Conflicts will happen in any MaaS ecosystem.
27_2	Varying stakeholder motives can lead to conflicts.
27_3	MaaS models cannot go ahead with conflicts.
27_4	The most influential partners should be given the chance in case of conflict.
	Outcomes of collaboration
28_1	Collaboration can create a level playing field.
28_2	Continuous innovation is an output of collaboration.
28_3	Collaboration can make competing partners work for a common goal.
28_4	Collaboration can thrive in teamwork.
28_5	Collaboration drives partners to provide extra commitment.
28_6	Collaboration creates new solutions and ideas.

3.3.6 Data collection

The target population of the survey was MaaS practitioners worldwide. Ethics approval was obtained from the University of Sydney Human Research Ethics Committee (HREC) under protocol number 2022/219. The data collection was conducted using the Qualtrics online survey management platform complying with data privacy and confidentiality. Due to the limited number of practitioners selective and snowball sampling strategies were used delegating careful consideration to the representativeness of the entire sample as detailed in section 3.3.4.

The survey distribution was conducted using multiple mediums to increase the response rate. In the first round, the survey was distributed using the feature in the Qualtrics platform which can track the completion of the responses while preserving anonymity. Initially, the response rate was low given the general tone of the invitations. Consequently, the remainder of the identified participants were invited through personal and customised email which resulted in an increased response rate. Further, survey participation was encouraged by promoting the survey at conferences and other events.

Overall, the survey was sent to a total of 257 potential participants out of which 94 participants (from 18 different countries) took part in the survey, representing a response rate of 37%. It was decided to complete the data collection at this point given the impact it

had on the time frame and the adequacy of the sample compared to the population of interest although it is not the optimum sample size for EFA. The smaller-than-expected sample size was compensated by adopting an extension of the EFA technique, namely Regularised Exploratory Factor Analysis (REFA), which compensates for smaller sample sizes with a larger number of measured variables. This is explained in detail in Chapter 5 under data analysis (refer to section 5.1).

3.4 Triangulation of the results

The need for mixed-method research has been indicated by methodological studies given its pragmatic nature and comprehensiveness (Bazeley and Kemp, 2011; Charmaz, 2017; Williams, 2007). Convergent validation and the ability to gain a holistic understanding are considered the main benefits of using a mixed-method approach. This can be achieved using both "within method' and "between methods" techniques (Jick, 1979; Yeasmin and Rahman, 2012). The approach adopted in this research is a between-methods approach where the findings of the qualitative phase are enriched by a quantitative phase to further the understanding of the phenomenon. The methods used in both Phase I and Phase II, namely CGTM and EFA are well regarded for their exploratory capability. This study leveraged the exploratory capability in both methods by complementing the findings with each other when arriving at the concluding remarks.

Initially, the two methods were intended to be used only as a means to verify the findings of each other. The similarities and differences between the models developed in Phase I was the point of departure (refer to section 4.4). Subsequently, the findings of Phase I and II were investigated to identify the level of convergence. Some of the constructs that emerged in Phase I were observed in the results of Phase II. Alternatively, there were some contradicting observations in Phase II as well. This divergence was considered an opportunity to enrich and extend the understanding (Jick, 1979; Williams, 2007) of the formation of trust and collaboration in MaaS ecosystems.

In undertaking such an exercise, it is suggested to use the domain experience of the researcher to search for patterns and relationships which improves the comprehensiveness of the results (Charmaz, 2014; Jick, 1979). Consequently, the underlying results of such changes were examined to obtain a comprehensive understanding. Further evidence was collected from Phase I to enhance the theoretical framework into a comprehensive theory while verifying the validity of the data as detailed in section 5.5. Subsequently, the

implications for policy and MaaS organisational modes are suggested in Chapter 6 drawing on the latter findings.

Despite the advantages, it is important to acknowledge the limitations of adopting a mixed-method approach. Typically, such studies are hard to replicate and reproduce given the involvement of idiosyncrasies involved in analytical decisions (Bazeley and Kemp, 2011; Jick, 1979; Yeasmin and Rahman, 2012). This study has attempted to reduce this by detailing the decisions taken in each stage including the qualitative phase. However, it is suggested to capitalise on the holistic nature and the ability to provide thick descriptions in qualitative studies rather than focusing on improving precision and reproducibility. To this end, the triangulation of evidence is conducted by comparing and contrasting the findings in Phase I and II systematically with the objective of improving the comprehensiveness of the findings. The next chapter discusses the findings of Phase I and Chapter 5 presents the findings of Phase II and the triangulated outcome.

CHAPTER 4 FINDINGS AND DISCUSSION - PHASE I

This chapter presents and discusses the findings of Phase I. The chapter starts with an illustration of the schematic diagrams developed to illustrate the ecosystems of each case study with a description of the composition of each ecosystem (section 4.1). Section 4.2 discusses the conceptual models and their emergent constructs, illustrating their interrelationships in the formation of trust and collaboration. The constructs that emerged as the outcomes of collaboration are explained in section 4.3. Section 4.4 concludes the chapter by providing a comparison between the two conceptual models and the underlying reasons for any differences identified.

4.1 Stakeholder relationships within the MaaS ecosystems

A clear understanding of the two MaaS schemes and the respective ecosystems would assist in interpreting the stakeholder experiences meaningfully. This section describes the composition of the two selected MaaS schemes and the interactions among different stakeholders. Further, it briefly describes the roles and responsibilities of the stakeholders within each ecosystem.

4.1.1 Sydney MaaS Trial

The Sydney MaaS trial (SMT) was initiated as a result of a partnership between the Institute of Transport and Logistics Studies (ITLS), Insurance Australia Group (IAG) and SkedGo – an app developer. iMOVE Cooperative Research Centre funded the majority of the project and the industry partners contributed both in terms of their financial and in-kind resources. Section 3.2.2.2 explains the design, development and objectives of the trial in more detail and this section mainly focuses on the stakeholder composition and their respective roles. The ecosystem of the SMT consists of several stakeholders some stakeholders had active participation while some had passive involvement. The key stakeholders include the MaaS operator (IAG), research coordinator (ITLS), app developer (SkedGo), investor/project coordinator (iMOVE) and the transport service providers (Uber, Cabcharge, Goget, Thrifty and Opal - the public transport smartcard which includes rail, metro, bus and ferries).

There were other transport service providers (TSPs) who were considered in the process of setting up the trial, however, the negotiations had not been successful mainly due to issues in cooperation. Even though most TSPs were interested in joining the trial as a business

opportunity, uncertainty of the outcomes compared to the number of resources and time that needed to be invested in the venture resulted in futile negotiations. The regulatory authority, Transport for New South Wales (TfNSW) had minimal involvement except for their participation as the public transport operator. Figure 4.2 illustrates the ecosystem of the *SMT* and the respective interrelationships are indicated through the arrows. The frequency of interactions among stakeholders is represented by the varying thickness of the arrows, with thicker arrows indicating more frequent interactions among stakeholders. The stakeholder key roles and responsibilities are listed in Table 4.1.

Table 4.1: Stakeholder roles and responsibilities in the Sydney MaaS trial

Stakeholder	Interactors	Functions
Insurance Australia Group (MaaS operator)	App developer, Research coordinator, TSP, Investor/Project Coordinator	Planning and designing the MaaS trial, planning and designing the features of the application, Managing the customer onboarding process, managing day-to-day operations, Executing the surveys to track the user behaviour, Developing the agreements with TSPs, Working towards achieving the milestones of the project
Institute of Transport and Logistics Studies (Research coordinator)	MaaS operator, Investor/Project coordinator, App developer	Designing and development of the MaaS project, Analysing the customer behaviour, designing MaaS bundles, Preparing the progress reports and required research outputs
SkedGo (App developer)	MaaS operator, Research coordinator, TSPs	Developing the application, Modifying the applications as requested by the MaaS operator, Setting up business accounts for each user
iMOVE (Investor/Project coordinator)	MaaS operator, Research coordinator	Monitoring the progress of the project, Managing the financial allocation, Arranging the necessary contract agreements for the project
Transport Service Providers	MaaS operator, App developer	Setting up business accounts for each user, Integrating the business payment systems with other users

4.1.2 Whim MaaS Scheme

Whim MaaS scheme (WMS) is considered the first commercial MaaS scheme in the world which emerged as an output of MaaS feasibility studies funded by the Ministry of Transport and Communications (LVM) and Tekes (now Business Finland) MaaS team. Section

3.2.2.2 details the initiation, development and current status of the *WMS*. One of the key issues faced by *WMS* in integrating with other TSPs is the lack of compatibility of the APIs even though the APIs are claimed to be open. Further, MaaS operators have experienced some issues with accessing mass public transport tickets due to the bureaucratic procedures existing in the public transport regulatory authorities.

The *WMS* ecosystem is centralized around MaaS Global, which plays the role of MaaS operator. The Whim app was an inbuilt application that was a result of continuous developments made by MaaS Global since its initiation. The other stakeholders include the LVM, Helsinki City Council (HCC), Helsinki Public Transport Authority (HSL), Finnish Transport and Communications Agency Traficom (Traficom) and the TSPs (TIER, Voi, Lime, Kaupunkipyörä, Juro, 24Rent, Toyota Rent a Car, Hertz, Sixt, Lähitaksi, Taksi Helsinki and Menevä). Figure 4.2 illustrates the ecosystem of the WMS and the respective interrelationships. The key stakeholder roles and responsibilities are listed in Table 4.2.

Table 4.2: Stakeholder roles in the Whim MaaS scheme

Stakeholder	**Interactors**	**Functions**
MaaS Global (MaaS operator)	Regulatory authorities, TSPs	Planning and designing the features of the application, Marketing and sales, managing day-to-day operations, Securing ongoing funding for MaaS, Developing the agreements with TSPs
Helsinki Regional Transport Authority (Regulatory authority, TSP)	MaaS operator, Regulatory authorities	Developing suitable APIs to integrate with the MaaS operators, Managing and operating the public transport network in the region
Helsinki City Council (Regulatory authority)	MaaS operator, Regulatory authorities, TSPs	Implementing the developments suggested by the regulations, Providing necessary infrastructure (digital and physical)
Ministry of Transport and Communications (Regulatory authority)	MaaS operator, Regulatory authorities, TSPs	Preparing the suitable regulations, Conducting meetings to consult with the stakeholders on the necessary interventions
Traficom (Regulatory authority)	MaaS operator, Regulatory authorities, TSPs	Enforcing the regulations, Managing the issues of the players in the transport landscape, and communicating such issues to the Ministry
TSP	MaaS Operator, Regulatory authorities, TSPs	Developing APIs compatible with the integration, Formulating suitable packages/discounts for the users, Creating user accounts

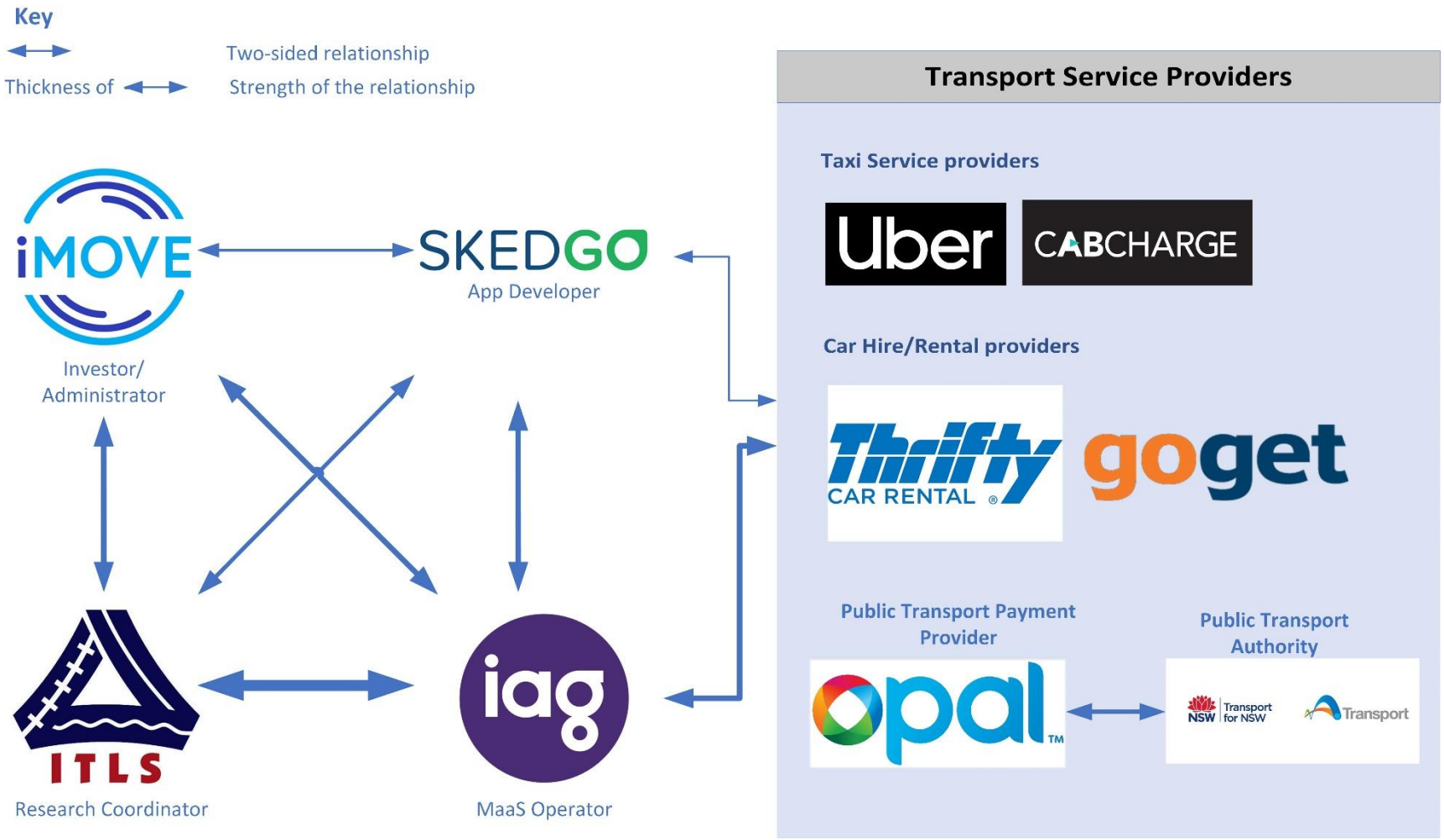

Figure 4.1: The stakeholders of the Sydney MaaS trial

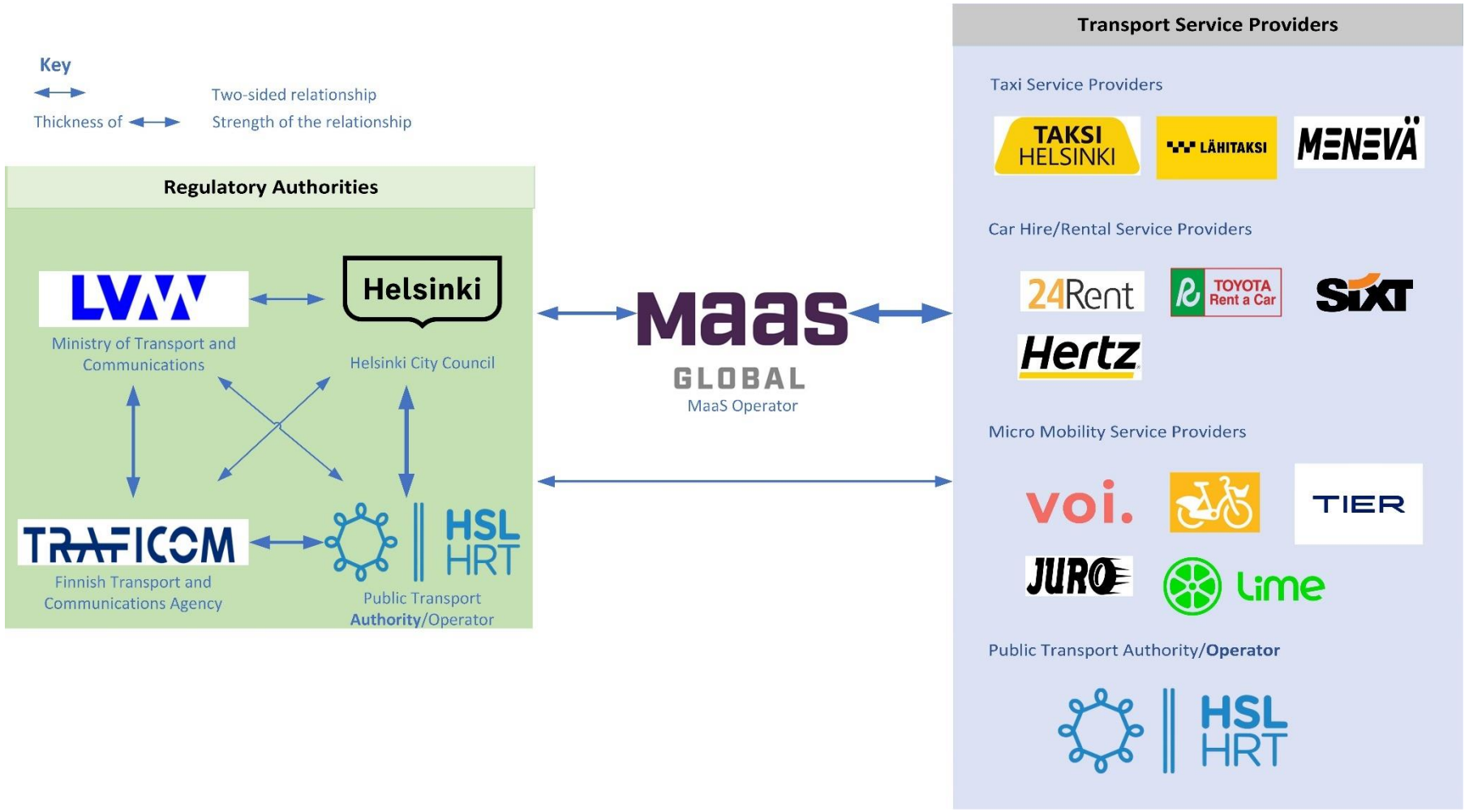

Figure 4.2: The stakeholders of the Whim MaaS scheme

4.2 Discussion on the factors that lead to Trust and Collaboration

Drawing on the analysis conducted in section 3.2.3, this section discusses the categories and concepts that emerged as the constructs of the two conceptual models. The section starts with an explanation of the contextual factors and then presents the conceptual models that were developed (one for each case) to illustrate the formation of trust and collaboration in the respective MaaS ecosystems. Subsequently, the constructs are explained accompanied by quotations from the interviews while explaining how these constructs affect trust and collaboration within the ecosystem.

4.2.1 Contextual Factors

Numerous studies have highlighted the importance of contextual factors in shaping MaaS developments and the formation of MaaS organisational models (Arias-Molinares and García-Palomares, 2020; Mladenović, 2021; Smith and Hensher, 2020; Veeneman, 2022). Contextual factors have both direct and indirect influence on the constructs that shape the formation of trust and collaboration in a MaaS ecosystem. Several contextual factors emerged through the analysis conducted in section 3.2.3 which are common to both case studies namely, *WMS* and *SMT*. These can be categorised under five key areas namely, the nature of the MaaS scheme, the nature of the transport network, the regulatory environment, user behaviour and ICT infrastructure. These are represented in the bottom right-hand corner of Figure 4.1 and Figure 4.2, separated from the constructs that are integrated into the conceptual models.

1. Nature of the MaaS scheme

This refers to the type of the MaaS scheme (e.g., MaaS trial, Commercial MaaS scheme, Public MaaS) and the stage at which it is in (e.g., implementation, development or maturity). The *SMT* was conducted under the trial setting which had a defined timeline and budget. These were highlighted as the confining factors that have obstructed some extensions of the trial, including the involvement of the transport service providers (TSP) due to uncertainties in extending to full-scale implementation.

> *"Now that I haven't talked about the duration of that trial is only six months, right? So, imagine how much of the extra volume you can talk about when you want to use the evidence to convince your transport provider, or partner to invest in the technology on a platform on the data end."* - SMT2 - MaaS Operator

> *"At the end of the day, we learn, and that's part of risk management, I would say, if you want to invest in any new products, you need to know the scope, or the potential of that product before you make a heavy investment. So even though, even if you are pessimistic, say, you know, you spend $300,000 for almost no confidence in terms of the future, you throw $300,000 out of the window."* - SMT1 - Research Coordinator

Alternatively, the trial environment provided the flexibility to the partners to adapt according to their learning experiences and to explore new arenas building upon the ongoing experience. Further, the industrial partners used this as an opportunity to explore the possibility of a scalable business case through this MaaS trial.

> *"I guess it's a way of ensuring that we learn more about them and understand, are they viable for Australia going forward, because it makes more sense to do these trials and test things and potentially start a big initiative in business that is destined to fail."* - SMT4 - Investor

In contrast, *WMS* is a commercial MaaS scheme and the expectations and the motives of the stakeholders in joining the scheme were underpinned by commercial interests except for the government and regulatory authorities. Further, *WMS* was continuously working on growth plans, strategies and ways to build an open environment such that it attracts more TSPs into its portfolio.

> *"I have full commercial responsibility and turnover and profit/loss responsibility on these markets, and that also includes partnerships, finding new partnerships keeping existing ones, and developing new models together with the partners in this region."* - WMS2 - MaaS Operator

Further, MaaS operator and TSPs of *WMS* were quite customer-focused, and they were aimed at providing *what the customer needs* rather than focusing on environmental and societal aspects. Interviewees from the *WMS* perceived striking a balance between these two goals as an arduous task.

> *"So, let's remember what we're targeting, it's to find something for the end user that is as being as owning a car. And if you only have societal goals in mind, sorry to say but you will not sell at all. Will you buy societal goals? No, you won't. Let's be realistic within. So, the hard part of this is if we only have short-term sales in mind,*

we'll end up with a situation that it will collide with the societal goals, that it will be the end of it, and, that cannot happen. So, it has to be a combination of the end user, attraction, societal goals and business goals. It can't be done, it's not like it's impossible, but it does take quite a lot of discussion and it takes leadership off someone who sets the vision of the markets." - WMS1 – MaaS Operator

The differences in the nature of the *WMS* and *SMT* impacted the factors that create trust collaboration and interactions in multiple ways. For example, the space for trial and error was greater in the *SMT* than in the *WMS.* On the other hand, the *SMT* met with difficulties when finding the TSPs, given the limited time frame, the small scope of the trial, and the uncertainty of potential extension to a commercial MaaS scheme.

2. Nature of transport system

The existing transport provision in a given jurisdiction has significant implications on a particular MaaS product. This includes the ownership structure of transport services, modal share and the availability of the different TSPs which cover the spectrum of transport modes such as bus, tram, car-share, rideshare, car-hailing and other active transport modes (CIVITAS ECCENTRIC, 2017; Liimatainen and Mladenović, 2021; Wong et al., 2020). Although both Sydney and Helsinki had suitable public transport networks, the maturity of car sharing, ride sharing and other micro-mobility transport providers in Helsinki appeared to be slightly better than in Sydney. This was evident through both interviews and existing government websites related to public transport (HCC, 2020; TfNSW, 2020).

"We started the business in Finland 2019 with 200 scooters in Helsinki [and] now after two and a half years, we have [operations in] nine cities in Finland nearly 10,000 scooters and in the big season, in the summer 150 employees. So it has been quite a journey for the last two and a half years." - WMS8 - TSP

"I don't think we started talking to users as much until we had the current transport providers in place. So I don't remember anyone wanting micro-mobility, it's also like micro-mobility from the like MaaS perspective is really interesting. It also has a much wider presence in Sydney. Although it's just not used that much, particularly bikes we found that culturally, this is not the infrastructure for it. So, we didn't really get a lot of feedback on that." - SMT7 - MaaS Operator

3. Regulatory environment

In Finland, several Transport Codes and Acts have been issued to support the development of MaaS products in an open market environment (refer to section 3.2.2.2). Further, Finland has decentralised the regulatory powers by creating multiple regulatory authorities at different levels of planning to ensure the implementation of emerging transport developments effectively. *Traficom* is the law-enforcing agency in Finland that ensures that the players in the transport landscape comply with the new laws and regulations. In the case of any dispute or clarification, they function as the bridge that connects the Ministry and the industry. Despite these hierarchical levels, TSPs are also allowed to discuss directly with the Ministry.

> *"So, the world is not ready, and we are still seeing how it turns out, it's a very young, emerging market sector, in that sense, we realized that already then this also means [more] supervising. So, our office 'B', that's the official name, is the supervising entity for seeing that this [Transaport Act] always abided, and everyone is playing according to the rules, and there have been a lot of discussions and disagreements on how to interpret the law."* - WMS3 - Regulatory Authority

> *"Of course, we sometimes hear things like that but it's the Ministry that makes the laws and then, they mainly discuss with them, or at least discuss the issues. Of course, we can tell when we do our own job that there is something we think is not working, working properly and then we can say that if, when they are changing the law, then they, this is something that you must consider that changes in some ways, or like that but mostly these stakeholders go, they discuss with the Ministry, straight from this law changing on or that you have to add some new sections or, like things that."* - WMS4 - Regulatory Authority

In NSW at the time of the SMT, the regulators were adopting a passive approach towards the developments such as MaaS although the intelligent transport systems were included under the TfNSW vision. This can be noted through the recently published reports by TfNSW such as *Future Transport 2056* and *Future Transport Technology Roadmap 2021-2024.* Further stringent regulatory hierarchies have made them a less useful partner for innovative developments.

> *"And the reason why is because the bureaucracy is such that we were concerned that we would lose control knowing how they work with other X[4] projects. I think that would have been the case."* - *SMT8 - Research Coordinator*

In the case of Finland, the government has developed suitable legislation to enable and enforce open data standards and open MaaS ecosystems creating a more conducive space for collaboration (Lajas and Macário, 2020; Mladenović and Haavisto, 2021; Mulley et al., 2023). These inherent differences in the approach pursued by NSW and Finland have resulted in some deviations among the constructs that emerged in those contexts.

4. User behaviour

The behaviour patterns of the customers have been shown to play an important role in designing a particular MaaS solution. The nature of existing user travel patterns and their attitudes towards ownership of private modes are found to have a considerable impact on designing a MaaS solution (Ho, 2021; Lyons et al., 2020). This needs a change across society and age groups rather than only in the millennial generation (Mulley, 2017). Findings from the analysis show that the residents in Helsinki are more attuned to using active travel and micro-mobility services to fulfil their short-distance journeys compared to Sydney. There has been growing interest among the public for a shift towards more environmentally sustainable travel modes and choices in both cities.

> *"Yeah. That must relate to attitudes and values. And I think today car ownership, it's still very dominant here, and if the government subsidises the ownership of the car, I don't know if it really change. You know, I mean, they don't subsidise the petrol or the diesel cars, but the electric cars."* - WMS9 - TSP

Changing user behaviour into a more sustainable and environmentally friendly pattern demands a user-centric solution and this was a key objective in both the *SMT* and *WMS*. Several studies have been conducted aimed at understanding the propensity to this change drawing on evidence from the Sydney trial (Ho et al., 2021a; Ho et al., 2021b). These studies indicate how the user perception of MaaS and travel behaviour have impacted the design and development of the mobility bundles and vice-versa. Studies emphasise the importance of offering incentives for sustainable travel behaviour to scale up the MaaS.

[4] The organizational names included in the quotes are converted to uppercase letters from the English alphabet, and the individual names are converted to lowercase letters from the English alphabet to ensure anonymity.

5. ICT infrastructure

The level of development of ICT infrastructure and the adoption of emerging technologies by TSPs impact the diffusion of MaaS in a particular context (Goulding and Kamargianni, 2018; Merkert et al., 2020; Meurs et al., 2020; Surakka et al., 2018). Sydney had well-developed ICT infrastructure and recognised app developers although TSP's technological adoption was sluggish. However, this varied based on the scale and the years of operation of a particular TSP. It was evident that TSPs were reluctant to invest a significant amount in improving their platforms without a reasonable indication of the return on such an investment.

> *"Some TSPs might have a very good technical platform, ready for you to integrate into the MaaS platform. Some are not. So let's talk about one example. We actually thought that we're gonna integrate T, instead of S as the car rental company in that trial. Because basically, Q owns most of T and S, right? But in the end, we can't actually integrate it simply because they are not technically ready yet. So, we manually integrate T, it is simpler for us, right? And the same way, go for U. So, we want to include U, because the network of U is much bigger and wider than V. And in some way, they are more cost competitive, if you like in terms of costs for the user. Yeah, but again, when we talk to them, they're not really great yet."* - SMT1 - Research Coordinator

In Helsinki, most of the TSPs were equipped with technological advancements that would enable them to integrate into MaaS-like solutions. This was partially due to the interoperable APIs enforced through the legislation.

> *"On the other hand, we've seen really good improvements. There's this quite small, Finish operator. But they've been active and just a few guys coding and creating those APIs and making sure they get the data in a relevant format and so on and they are focusing on reselling long distance, train and bus trips. And so they've been quite successful in that and they haven't had the type of issues that A has. So there's, there have been some encouraging developments as well."* - WMS3 – Regulatory *Authority*

> *"We do see new providers that have state-of-the-art APIs that work without a problem. We do see, some partners who have basically their servers in their office.*

And we do see cloud-native companies… it's like that in this industry it varies a lot." - WMS2 - MaaS Operator

Adequate technological competency is found to be crucial to proliferating the MaaS developments. It is evident that with the rapid pace of technological development, both Sydney and Helsinki had well-developed ICT infrastructure. However, in the context of this study, Helsinki was slightly better than Sydney in terms of the level of maturity of TSPs in adopting these technological developments to leverage their business opportunities.

4.2.2 A reader's guide on referring to the Conceptual Models

As elaborated in section 3.2.3, the Constructivist Grounded Theory method was used to analyse the data collected in Phase I with the objective of understanding the formation of trust and collaboration in *SMT* and *WMS*. Figure 4.3 and Figure 4.4 illustrate one of the key outcomes of the analysis i.e., the conceptual models developed for *WMS* and *SMT*. The contextual factors are shown separately at the bottom of the right-hand corner of each figure.

The readers should read these figures starting from constructs that form trust which are represented in light orange colour. The constructs and sub-constructs that form collaboration are represented with light purple shading. The constructs, trust and collaboration are placed at the centre of the figures as they are the main concepts that were explored. The arrows moving outward from a construct show the constructs that are influenced by the respective construct. Consequently, the arrows moving toward a construct show the constructs that influence a particular construct. The outcomes of collaboration are represented in green colour. Section 4.2.3 explains the constructs in detail to show how the respective construct interrelates with the other constructs in building trust and collaboration in each of the two case studies.

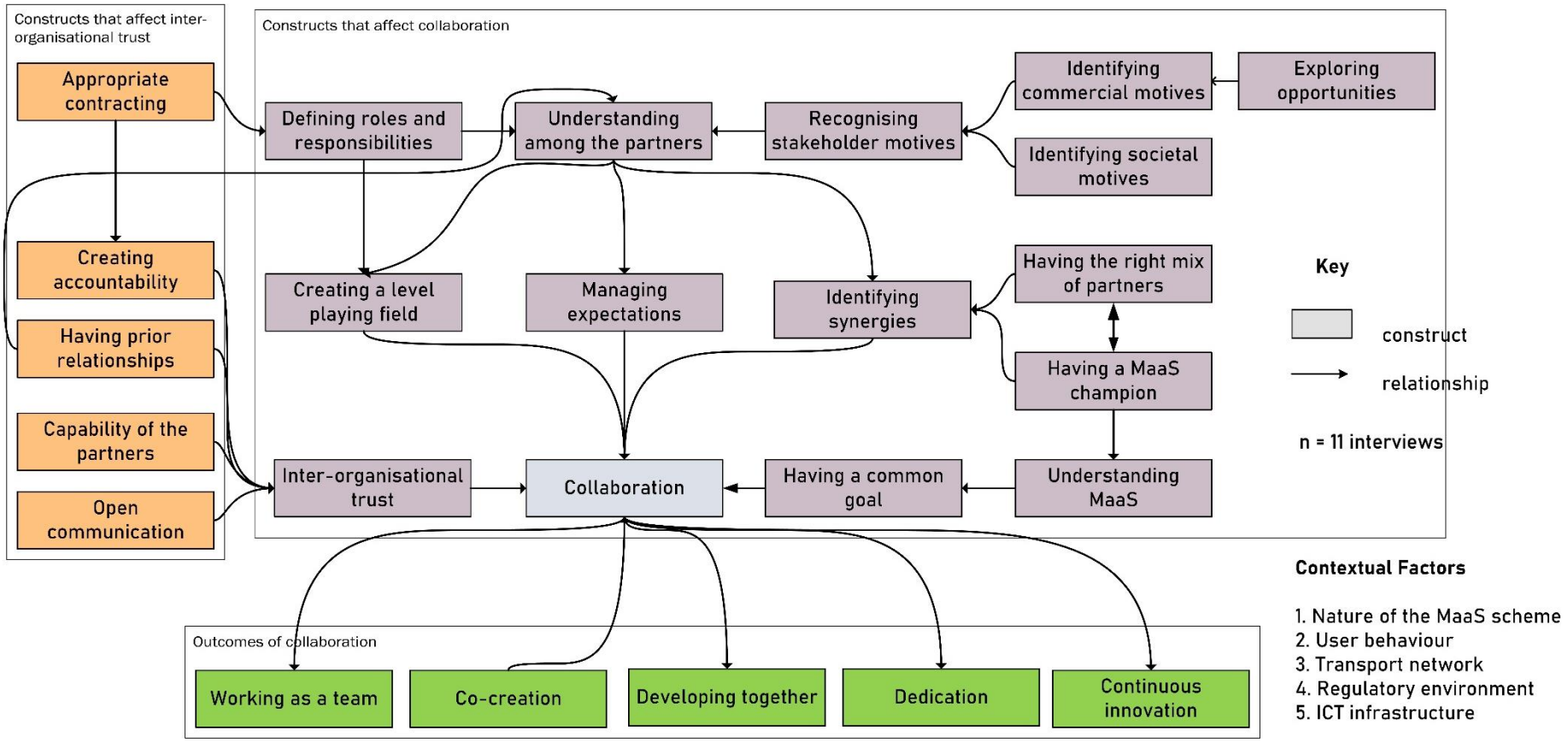

Figure 4.3: Conceptual model for trust and collaboration in Sydney MaaS trial

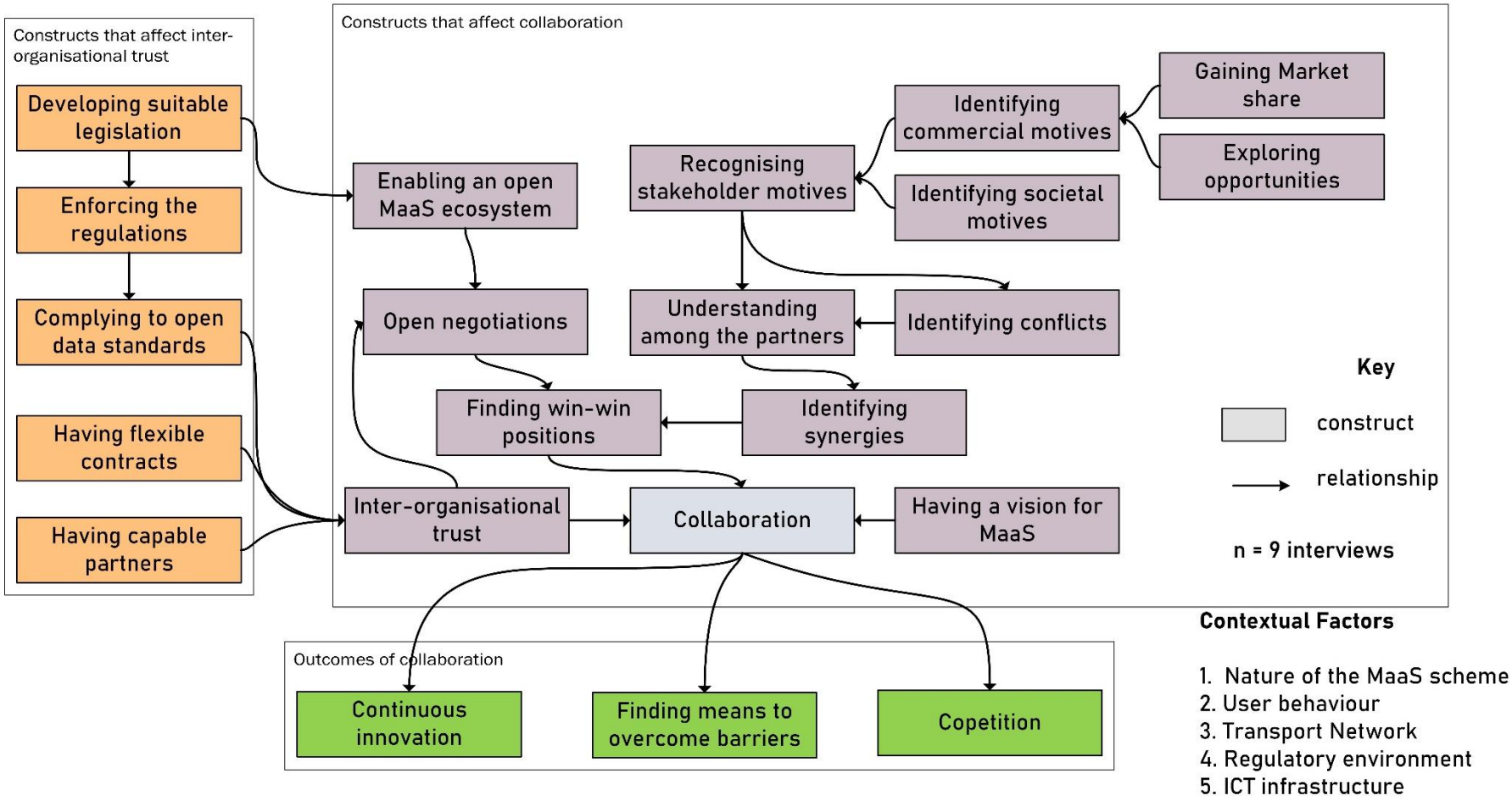

Figure 4.4: Conceptual model for trust and collaboration in Whim MaaS scheme, Helsinki, Finland

4.2.3 Factors that build inter-organisational trust

Trust extends to inter-organisational trust in the context of relationships among organisations. Hereinafter trust and inter-organisational trust are used interchangeably when referring to inter-organisational unless specified otherwise. Stakeholders in both ecosystems firmly believed that trust is quintessential in forming sustainable MaaS products given the uncertainties in the future trajectory of MaaS. This section summarises the factors that build trust in the two ecosystems.

Inter-organisational trust emerged as a key element which enabled efficient and long-lasting partnerships among the stakeholders. This was evident through the comments of the participants in both case studies. Hence, *inter-organisational trust* (similar to *collaboration*) is placed at the centre of Figure 4.3 and Figure 4.4. The constructs that form trust are highlighted in a light orange shade and the arrows moving outwards show the constructs influenced by the trust. In the case of *WMS* trust appeared to have formed incrementally with time, whereas in the *SMT*, trust was established in a rather short period, given the prior relationships that stakeholders had with each other.

> *"That you can have a billion dollars but you will not buy trust with it. So it's a hard act to follow. Trust is normally between people...."* - WMS1 - MaaS Operator

> *"Well, I think so and that's because there was huge trust and partnership as xx and yy said, the partnership with zz is wonderful, we trust you, we like you, and that's in my in my big talk on the MaaS trial which I gave in the end, that was fairly clear that building trusting relationships is so crucial."* - SMT8 - Research Coordinator

> *"Of course, we have to take into account if they have any hidden agendas behind it or something like that. I do believe that this kind of MaaS operational ecosystem model that we have built is based on trust or mutual trust. So, we also as an operator can't have hidden agendas either, otherwise it won't work."* - WMS2 - MaaS Operator

The improved levels of trust created a conducive environment for stakeholders to take dynamic decisions which are mandatory for the innovations at an early stage. Stakeholders in both ecosystems were in common consensus regarding the difficulty of formulating exhaustive agreements, which heightened the necessity of trust among the players in the ecosystem. This aligns with the proposition of Meurs et al. (2020) regarding the importance

of trust in the exploration phase of a MaaS project given the difficulties in developing formal contracts.

> *"And so I think there's a lot that goes into a project that can't necessarily be put down on a contract, I mean something as simple as how you treat each other, you know you can yell and scream if you want to but that's not going to be conducive to a good project and you know you're not really going to have anything in a contract, talking about, you know how… yeah, the volume that you talk at the way you approach people so there is a lot. I think there is a lot implicit."* - SMT5 - MaaS Operator

Although trust is important despite the model under which the stakeholders operate, the open market ecosystem of *WMS* necessitated the implicit trust between the stakeholders to function appropriately. Typical opportunistic behaviours are not regarded as acceptable in such environments.

> *"We've been pretty open towards the partners, relating the topic that we have more and we will not make any exclusive deals with anyone, because we do believe that the on the open ecosystem that also our partners contribute other ecosystems as well. We are not forcing any of the partners to make an exclusive deal with us, because we believe in the open ecosystem and the competitiveness that when there's competition, the end user is the one who benefits, and that will also push us to faster develop our services."* - WMS2 - MaaS Operator

The constructs that emerged for the two cases had some differences mainly due to the differences in the contextual factors explained in section 4.2.1. In Figure 4.3 and Figure 4.4, it can be observed that only the construct of *having capable partners* is common in both models while other constructs are exclusive to each MaaS scheme.

4.2.3.1 Factors common to both ecosystems

1. Having capable partners

Stakeholders in a MaaS ecosystem should possess adequate and complementary capabilities to perform their expected role in order to deliver a value-added MaaS product (Arias-Molinares and García-Palomares, 2020; Meurs et al., 2020). For example, the technological capability of the partners is one of the key factors that are necessary for MaaS schemes to integrate with each other seamlessly. The capability that is expected by the other

stakeholders depends on the role that a particular stakeholder plays in the MaaS ecosystem. In the case of the *SMT*, the partners were selected based on their recognition in their field of expertise. Although the partner selection was initially governed by the prior relationships, the capability became the sieving criteria.

> *"Yeah and that's sort of on a broader picture, obviously on a more individualized picture we're interested in collaborating with both university, and commercial partners such as Q to understand, because their goal was to understand the viability of such a platform, and how MaaS would operate in Sydney and so we were also interested in participating that providing our expertise to, you know, to both sides and the parties, both those other stakeholders, to be able to enrich that research and push the agenda of Mobility as a Service as a viable option in Sydney and globally."* - SMT3 - App Developer

> *"But as I said at the start, we don't have that technical knowledge that a lot of these research projects need. So, we will provide that governance oversight role, and I'm sure the other team members mentioned to you that there was a webinar, held at the end of the project as well, to share the learnings. So that's something that X hosted and organized with the partners and ran. So that's again where we assist; sharing and dissemination of the learnings, but the technical elements, no, they are good: the university and the industry partner."* - SMT4 - Sponsor/Administrator

WMS adopted an open market approach when selecting the partners to their ecosystem and hence the stakeholders needed to be competent in their service delivery as there are replacements for most stakeholders in an open market. On the other hand, as the market is open for any other MaaS operator *WMS* needed to improve itself continuously to retain the partners in the long run. However, the case was different for the public sector stakeholders who appear to have a unique capability in shaping the direction of MaaS developments through regulatory interventions. This has been recognised in the literature by numerous studies (Mladenović and Haavisto, 2021; Mulley and Nelson, 2020; Smith and Hensher, 2020; Smith et al., 2018b).

> *"I would say that we can't use the stick, we have to use the carrot, but governments and municipalities might be able to use the stick, but I would say that's okay, why don't use both of them, give them tax exemptions for them if they travel in a sustainable way. And also might be, do something with the regulations in the cities,*

regarding increasing the parking costs or things like that. There's so much that government can do, and municipalities can do." - WMS2 - MaaS Operator

4.2.3.2 Factors exclusive to Sydney MaaS trial

The factors discussed in the below sections emerged as the constructs that created trust in the *SMT* other than *having capable partners.* These are illustrated in the right-hand side of Figure 4.3 indicating how these constructs interrelate with each other in creating *inter-organisational trust.*

2. Appropriate contracts

Participants in the *SMT* believed that the agreements developed by *iMOVE* created a legal obligation by assigning specific duties that a particular stakeholder should perform. They perceived that this made the stakeholders accountable to a single overarching organisation. The contracts have defined the roles and responsibilities of the stakeholders while providing adequate flexibility given the dynamic nature of the MaaS trial, which possesses a changing structure. This aligns with the views of Meurs et al. (2020) and Smith et al. (2018b) regarding the nature of the contracts in a MaaS Scheme which is in an exploration phase. The agreements had room for change both in terms of time and funding under reasonable circumstances.

"So we had all that and then after the contract was signed, we expected and it's fairly common with X research projects, to have contract changes or variations around timing or whatever because you make an assumption around what's going to happen and what the timings are budget is, but you don't necessarily know what the full piece will be. So we did make changes, we increased the funding, I think specifically to bring in some incentives into the model. We increased it to cover some of the costs of Z's development that had been under-assessed. And then of course, when COVID hit, we were still partway through the trials, so we had to change the last month or two of the trial because no one was moving. So that's never something that you could foresee. So that contract variations were all amicable." - SMT 10 - MaaS Operator

"So… I think in a MaaS context going forward I think it would be very hard to say that a single contract you know, would capture all elements of a MaaS platform going forward because I think there are a lot of variables in how this all works

different service providers, public, private entities, who's the who's going to be the operator of the MaaS platform versus you know something like the university who was doing an analysis side. So, in this particular case, it wouldn't have worked to try and get every player in the trial to be a signatory to a single contract." - SMT4 - Sponsor/Administrator

Transparency of the terms and clauses was highlighted as a key feature of an appropriate contract. Given the nature of the trial, transparency was created through the explicit project agreements among the stakeholders, except with the transport service providers who had separate contracts with the MaaS operator. This assured the absence of any hidden agendas behind the contract to a certain extent.

"Intellectual property funding and sort of outcomes like those things have to be held [through] very open conversations and I think the personalities involved meant that those were direct and open conversations." - SMT 10 - MaaS Operator

"But if we are to share that information with third parties in the future, for MaaS to work, I think that needs to be done in a very considered transparent way. And the customers are made aware and then we require customer consent. We need them to opt into having this information shared in order for them to access certain products and services. So I think that's very much the direction that we would need in order for this to work." - SMT 9 - MaaS Operator

3. Creating accountability

The responsibility of each partner to achieve or fulfil their given role appeared to have a considerable relationship with trust. Stakeholders perceived that this could be created through appropriate contractual agreements. However, this does not suggest impeding the flexibility that the contract has given to partners to amend their agreed deadlines and outputs as the project progresses in the face of unexpected findings, learnings and circumstances.

"So, from an X perspective, we would see that Q is responsible for the communication and the contracting with the transport providers. We don't need to see the specific arrangements and agreements that have been made between Q and those transport providers, because from our perspective we're holding Q accountable for the delivery of those relationships if that makes sense." - SMT4 - Sponsor/Administrator

4. Having prior relationships

Initiation of the *SMT* itself is a result of the prior relationships which existed among the stakeholders. The personal relationship between two different decision-makers in partnering organisations can also be accounted as a prior relationship. These personal relationships were a key factor behind selecting the partnering organisations in the *SMT*. Such a selection is motivated by the limited time frame of the project which does not have adequate time provisions for the stakeholders to familiarise themselves with each other. Another effect of prior relationships is referral trust, where some stakeholders preferred trusting business partners of their current partnering organisations over random organisations in the same field. Both excerpts listed below provide a perfect scenario of how this happened in the *SMT*. However, it is important to note that the stakeholder capability was a necessity despite having prior relationships.

> *"Absolutely crucial. If you work on the bits individually to get trust, and when you start bringing them together, you still need to build other connections in the trust equation between subsets of people that may not have worked together but if they trust us, it's easier for them to trust one of the partners that we trust. I think that's an important point so trusting partnerships, which is a famous Thredbo[5] term. It's not a matter of having partnerships, they must be trusting partnerships, otherwise, I don't think any of this would work, because the whole supply chain of MaaS is only as good as the weakest link."* - SMT8 - Research Coordinator

> *"Now, I mentioned to y_1[6] that I thought MaaS was a possibility, and whereabout that time, X introduced me to z, who's this is in charge of Z, the general manager, he [who] started it. And he came across to the university and y_1 and I met with him[z]. And we told him about the work that we had been doing with the SP stuff and he felt that nobody else had been looking at the customer side, to the extent that we had was a good idea. So, I decided that wouldn't it be good if we could find some way of working together. At the same time, I had addressed X's committee, generally, they wanted me just to tell them about Y. So, I went to a meeting of the board and one of the board members was q_1 from Q, and I got along really well*

[5] International Conference Series on Competition and Ownership in Land Passenger Transport (The Thredbo Series) is a conference dedicated to foster the discussions among industry and academia towards emerging transport problems and solutions.

[6] The lower case letters (which represents individuals) were affiliated with a subscript to differentiate individuals from the same organisation.

with q and so after that meeting, I thought that, wow, maybe Q could be a partner because you have to have an industry partner." - SMT8 - Research Coordinator

"So, we had a fairly long relationship with Y, specifically y_2. *So, as I understand it, Chairman z, who's one of the founders, he had a long relationship with Y. We were generally involved with anything, intelligent transport systems related. So that was one of our industry contacts and from what I understand,* y_2 *was looking to do some research and knew us as an app developer and provider and a MaaS provider as well. And yeah, I think he reached... he brought qq into the project, and he contacted us as an app developer so yeah... it was, I think we were contacted by Y."* - SMT3 – App Developer

Previous experience in working together on a common task was another avenue through which the prior relationships were formed in *SMT*. In instances where the partners have acted with integrity, the continuity and effectiveness of the relationships has been thrived. On the other hand, if the experience is negative, it has created an impedance against trusting relationships despite the capability that the respective partner possesses.

"And not just a relationship but a commercial relationship. The TSPs had a lot of concerns around well, am I going to be undercut you know, I don't want to be sitting next to this one and competing on a platform where you're effectively aggregating our service. And we understand that because we don't like doing that when someone tries to do that to insurance as well. So, I think it was the fact that it was a trial. It was only 100 people. They didn't have to do huge, they needed to make some changes to the systems, and they could benefit from the innovation association. But they didn't have to suffer to take a commercial hit. And it was already part of that existing volume, commercial volume that we're giving them." - SMT10 - MaaS Operator

5. Communicating openly

There was frequent communication among the partners who were involved in the trial. All the project meetings were conducted in a transparent way involving the necessary decision-makers without having any closed group discussions. Although there were a few dominant partners given the nature of their role, all the participants had an equal opportunity to provide their suggestions and perspectives. However, there was a lack of involvement from TSPs in the meetings given the passive role that they played in the ecosystemdue to the

nature of the trial environment. Nevertheless, the key decisions were communicated to them via emails and progress reports.

> *"Intellectual property funding and sort of outcomes like those things have to be held very open conversations and I think because I think the personalities involved meant that those were direct and open conversations. There was nothing that we shied away from in having in putting on the table. That's a really important part of why it worked. There's been other projects not related to this where that hasn't been as openly addressed, which is what we've learned from."* - SMT10 - MaaS Operator

> *"But when we were all sitting down talking about the project, it was, you know, exciting and everyone was really keen to work with each other."* - SMT5 - MaaS Operator

4.2.3.3 Factors exclusive to the Whim MaaS scheme

The factors discussed in the below sections emerged as the factors that created trust in the WMS other than *having capable partners.* These are illustrated on the right-hand side of Figure 4.4. How these constructs interrelate with each other in creating *inter-organisational trust* is discussed below.

6. Developing suitable legislation

The regulatory environment was included previously as a contextual factor. *Developing suitable legislation* stands for a slightly different construct which represents the direct involvement of the regulatory authorities in developing and enforcing the MaaS-related regulations. This includes developing suitable regulations such as data standards and subsidisation schemes which enable the formation of a conducive environment for MaaS developments (Hensher et al., 2020; Kamargianni et al., 2016; Sochor et al., 2016; Surakka et al., 2018). This was highlighted as one of the key factors which facilitated the formation of MaaS schemes in Finland.

The *Finnish Ministry of Transport and Communications (FMTC)* has been involved in creating a conducive environment for emerging transport developments by developing a Transport Act which includes facilitating open market ecosystems and developing open data standards (FMTC, 2018). Further, the *FMTC* has conducted workshops with different stakeholders in the process of developing these legislations to have a more reflective and pragmatic set of regulations. These regulations have assisted in enabling the *Helsinki Public*

Transport Authority (HSL) to collaborate with private actors by integrating the APIs and the ticketing systems. Further, local authorities such as *Helsinki City Council (HCC)* had to align their design and development plans with the recent regulations.

> *"But, after that, then, sort of the legislation developed, the first parts of the Transport Act was probably 2017. The first section of the Transport Act was decided and then the most significant part was the second part. And that was in the spring of 2018. In my department, I'm responsible for, say, marketing and sales for that, and then my colleague is responsible for technological solutions. So my department was preparing those MaaS contracts. And my colleague, they were building the MaaS interface. - WMS5 - Regulatory Authority*

7. Enforcing regulations

This stands for the operational support received from the regulatory authorities to enforce the laws and regulations related to MaaS developments. In Finland, the regulations are enforced by *Traficom*, the agency that ensures functioning, safe and reasonably priced transport and communication connections and services in Finland. The regulatory bodies at the different levels (city councils, public transport authorities, etc.) were required to enable the developments such as MaaS and one of the intentions of *FMTC* forming the regulatory body, Traficom to assist such developments. *Traficom* is actively involved in the transport landscape and resolves problems and disputes among stakeholders in the transport landscape including MaaS. This helped to implement regulations related to MaaS using a participatory approach.

> *"And they have been even on court with some of the TSPs about their actions and whether it is correctly opened or not. It's a bit of a different way of creating trust through regulation, where if we compare that with… I often use the Antwerp case where they took a bit of a different route."* - WMS1 - MaaS Operator

> *"So, our office 'B' is the supervising entity for seeing that this always abided, and everyone is playing according to the rules, and there has been a lot of discussions and disagreements on how to interpret the law."* - WMS9 - TSP

> *"But that's a little bit hard when you are trying to develop this because all the parties or stakeholders are not willingly here, but they have to be."* - WMS4 - Regulatory Authority

8. Complying with open data standards

This is enabled by the set of regulations and agreements that assist people and organizations to publish, access and use better quality data. These protocols have made the applications among TSPs more functional and interoperable. As mentioned before, this was initiated in Finland through appropriate legislative interventions and enforcement (Mulley et al., 2023; Surakka et al., 2018). Although there is criticism of the authority of the government to enforce such regulations MaaS operators and some TSPs viewed this as a key factor which ensures trust among the MaaS stakeholders.

> *"Now, when you make legislations to open all the interfaces, for C, it means that, you know, we need to we need to be open for everybody, not just for MaaS Global, not just for some Onnibus company. We need to have a common, sort of solution for everybody. It restricts a little bit the API, the solution we offering."* - WMS5 - Regulatory Authority

> *"Data regulation that was as far as we know the first of its kind in the world, where it's necessary for providers to open up the data about their services."* - WMS3 - Regulatory Authority

> *"So regulatory framework is done in a way that this is particularly dependent. And it's a bit different, for example, in Antwerp, and in Switzerland, and a few other places. Finland has the general law of the Transport Code, that kind of obliges for opening up all the APIs with fair non-discriminatory contracts."* - WMS1 - MaaS Operator

9. Having flexible contracts

This mainly refers to the agreements that the MaaS operator has with the TSPs, app developers and other stakeholders. In the case of *WMS*, since *MaaS Global* acted as both the app developer and the MaaS operator, the contracts that existed were mainly between *MaaS Global* and *TSPs*. However, unlike the contracts in *SMT* which have defined the role and responsibilities, in WMS the contracts were based on market-led agreements. The contracts were quite flexible and staggered such that changes were accommodated based on the circumstances and developments (Meurs et al., 2020). This includes negotiable terms and conditions which can be discussed openly among the agreed parties.

"Of the contract? Yeah. We see it's flexible, and it's always negotiable. Well, at least this is our feeling. We haven't had quite many changes during these years yet, but I'd say that we have a good dialogue. So, if we need to do something for the contract, I assume that would be doable." - WMS9 - TSP

"So, of course, different partners have different levels of technical capabilities as well. So we definitely have to have different kinds of agreements. For example, an agreement with the public transportation might not work with a taxi provider for example." - WMS2 - MaaS Operator

"Exactly, we don't have, sort of [clauses] in normal IT agreements you usually have service level agreements, maintenance windows, you have to report things, you have to have up time of 99.8% otherwise there will be a fine or something like that." - WMS2 - MaaS Operator

4.2.4 Collaboration in MaaS ecosystems

This section discusses the factors that lead to a collaborative environment within a MaaS ecosystem. Collaboration is defined as the process through which parties share information, resources, activities, and capabilities and search for solutions that go beyond their limited vision of what is possible (Bedwell et al., 2012; Getha-Taylor et al., 2018; Gray, 1989). Fortunately, most of the stakeholders in both *SMT* and *WMS*, understood that MaaS needs trust and collaboration. Hence, collaboration was evident in both MaaS ecosystems, but the factors and their interactions in forming a collaborative environment had some notable differences.

Inter-organizational trust emerged as a necessary prerequisite for collaboration in both case studies. In the *SMT*, *having a common goal*, *identifying synergies*, *managing expectations*, and *creating a level playing field* emerged as the other prerequisites. Alternatively, in *WMS*, *having a vision for MaaS*, *identifying synergies* and *finding win-win solutions* emerged as other prerequisites. *Understanding among the partners* emerged as an underlying construct which facilitated the formation of some of the above constructs such as *identifying synergies* and *having a level playing field.* The analysis captured some of the sub-constructs underlying these key constructs and these are detailed in the remainder of this section. The left and middle areas of Figure 4.3 and Figure 4.4 include the factors that lead to collaboration in *SMT* and *WMS*. These further illustrate how each of these constructs and subconstructs interacts with other factors in the process of building trust and collaboration.

"Yeah. So we obviously wanted the contract to reflect that. You know, it wasn't a contract for services, it was a collaborative research project." - SMT5 - MaaS Operator

"So, I think that there's a sweet spot in the middle there, where we can get that win-win type scenario, but it's a tricky one. It requires considerable effort to communicate and negotiate that position." - SMT 9 - Regulatory Authority

"But, of course, public transportation is also learning and developing… Or it might be that they could take the micro-mobility solution to a train station where there might be a good connection to where people work, so you need a combination of all." - WMS 2 - MaaS Operator

Understanding the need to collaborate was quintessential in the process of negotiation and entering into agreements. However, the ways and means of formulating and sustaining such agreements remained open questions for the stakeholders. In both *SMT* and *WMS*, the majority of the stakeholders were willing to collaborate, but they were still on their journey to find a workable ecosystem.

"I think that's sort of embedded in the way that we work. So, our goal when working with partners is to ensure that it's cooperative research that we're doing. It's a different nature, we're not contracting, you guys to do something for us. We're exploring something together so we're pretty sure that we're meeting each other's needs and that we're working together on things [that] were really important to us." - SMT5 - MaaS operator

"Yeah, and that's sort of on a broader picture, obviously on a more individualized picture we're interested in collaborating with both University, and commercial partners such as Q to understand, because you know their goal was to understand the viability of such a platform, and how MaaS would operate." - SMT3 - App Developer

"So, anyone trying to avoid that question of what kind of democracy we have in Australia, in the US and South Africa, or Finland or Sweden, as I said, democracy in Sweden, is also different from the one in Finland, even if their neighbouring countries, they oftentimes put in the same group. They look like they're the same but they're not the same. Democratic system is substantially different if you know what

> *to look for. Even between Sweden and Finland. So, I would say that this kind of collaboration and trust building needs to start from really understanding those two fundamental principles, understanding people and understanding the democratic system in where people live in, two easy questions."* - WMS7 - University

The remainder of this section describes the constructs that form collaboration within the MaaS ecosystems. The constructs are presented sequentially without grouping the constructs exclusive to each case unlike in section 4.2.3. The intention of structuring the factors sequentially is to offer the reader a clear and structured understanding.

1. Understanding among the stakeholders

This refers to the mutual understanding among stakeholders themselves. The stakeholders in the *SMT* had an initial understanding of each other from the start given the prior relationships that they had with each other. This enhanced when they understood the roles, responsibilities and motives of other partners in the process of entering into contracts. Hence, *having prior relationships, recognising stakeholder motives* and *defining roles and responsibilities* emerged as the sub-constructs under *understanding among the partners* in *SMT*. The sub-constructs that build the *understanding among the partners* in *WMS* were quite similar to the *SMT,* although the understanding they had of other stakeholders' roles and responsibilities was limited. Alternatively, stakeholders in *WMS* have *identified the conflicts* among the partners and have succeeded in finding solutions to such conflicts and arriving at a common understanding. In *WMS* this understanding resulted in *identifying synergies* among the stakeholders whereas in *SMT* this assisted in *creating a level playing field, managing expectations and identifying synergies.*

2. Recognising stakeholder motives

Every stakeholder in the MaaS ecosystem has both implicit and explicit motives for joining the ecosystem (Meurs et al., 2020; Mulley and Nelson, 2020; Smith et al., 2018b; Surakka et al., 2018). Stakeholders at least expect their explicit motives to be recognised and accomplished by joining a particular MaaS ecosystem. The motives that led the stakeholders towards joining the *SMT* and *WMS* can be grouped under two categories namely, societal motives and commercial motives. In the *SMT,* industrial partners such as *IAG* and *SkedGo* had the intention to see the commercial viability of the solution as a potential business case that also aligns with their sustainability initiatives. Alternatively, *ITLS* and *iMOVE* were mainly focused on assessing the potential of achieving societal

benefits promised by MaaS. This led to a reasonably high emphasis on societal goals compared to commercial goals. In the context of *WMS*, commercial motives took precedence as public agencies anticipated it to function as a self-sustaining product, independent of financial support from the government.

> *"Public transport authorities are completely a different universe… they have completely different goals, completely different mindsets and so on and xx or something."* - WMS1 - MaaS Operator

> *"And even though the intellectual property was retained by us we made sure that it didn't impact the ability of the university [to] published papers, and our goal was to see if there was any commercial opportunity for us in this, and our goals were looked after as well."* - SMT5 - MaaS Operator

a. Identifying societal motives

This refers to the motives that are formulated with the intention of achieving the issues faced by society due to current transport patterns. The key societal motives of the stakeholders included reducing emissions, reducing traffic congestion and shifting people away from car use. In the present context, the private sector is increasingly interested in such sustainable initiatives as an attempt to gain a social license. The public sector usually prioritises societal goals over commercial goals given the importance of such decisions in the long horizons. This was evident from the comments of the *PTA* even though they only had a passive involvement in the trial. In the *SMT*, most of the partners involved identified with the societal motive to initiate a solution that induces sustainable travel patterns.

> *"Not just because we think it's a compelling offering to customers, but it also is from an active transport perspective and we're very supportive of customers using that as a means of being able to access our backbone network. We think it's good for citizens, health and wellbeing benefits but also from a sustainability perspective we think that's a kind of really positive way of contributing towards our broader government objectives and goal of reaching zero carbon emissions or net zero carbon emissions by 2050. So, ``there's a very supportive role."* - SMT9 - Regulatory Authority

> *"I would hope so because level four is to achieve societal objectives and to be honest, if they think that they can turn this thing around and make it commercial*

without achieving any societal objectives, then I guess you can't stop them from doing it, but that has no value to society and so governments should not contribute a cent." - SMT8 - Research Coordinator

"And then the other side of it is, we had a big push for sustainability and trying to change behaviour at the same time which fit well with Q"s kind of broad vision of making the world a safer place, and climate change is a huge challenge for insurers and increasing disasters and claim costs are skyrocketing especially in certain regions. So, there is also a big push around Q to be involved in contributing to studies that show promise in reducing carbon emissions or improving the sustainability of, transport and or building materials and that type of thing. So we don't see a catastrophic increase in claims and we make the world a better place to live for everybody." - SMT2 - MaaS Operator

Although the TSPs did not emphasise societal motives, other stakeholders in the *WMS* ecosystem shared the motive of promoting a sustainable solution that shifts people away from cars and thereby reduces emissions levels.

"Well, we see MaaS, as part of the toolbox, we need to have in order to get those societal goals, reach those goals. We need to reach and mainly those are reductions. Reducing emissions, creating more livable cities, and improving the accessibility and sustainability in general, for people. So, those are those are probably the main goals." - WMS3 – Regulatory Authority

b. Identifying commercial motives

Commercial motives were prominent among the stakeholders who joined the *WMS* as it is a commercial MaaS product. These commercial motives can be further segregated under two key areas namely, gaining market share and exploring business opportunities. Even though the stakeholders in the *SMT* had a strong focus on societal goals, TSPs were mainly interested in commercial motives.

i. Gaining Market Share

TSPs believed that MaaS can assist in leveraging the market share specifically for car-sharing, ride-hailing and micro-mobility operators. This is due to the need for first and last-mile connectivity opportunities for car users who are attracted to

MaaS. Hence some TSPs view this as an opportunity to gain market share and ultimately profitability.

> *"But for us, I think we find it very useful to be in part of the system, of course, it's something else in times like this and to gain more local car rental or local bookings from let's say, from the Helsinki district. So that would be very beneficial for us, and we will have more boost [during] low season. So, we get a little push from their side, we get new customers."* - WMS9 - TSP

Some TSPs consider this as an additional sales channel for their existing product as it gives TSPs a chance to be included on another app in the user's mobile phone in addition to their exclusive application.

> *"It's an additional sales channel for us, of course, in that we are not only independent on our own Earth. There's a huge competition, who will get the apps on people's phones? There's a limited capacity in the mobile phones and we do not want to have 300, you can't have 300 apps. So it's good that if you can be a part of as many apps as possible, then you have a chance to get as many customers and be relevant. So that was one thing."* - WMS8 - TSP

ii. Exploring business opportunities

This is indirectly related to the concept of gaining market share. In the present context, the private sector is increasingly interested in business opportunities which have an element of sustainability. This can be frequently observed in the transport sector due to the increasing interest in sustainable products from the general public. In both *SMT* and *WMS* ecosystems, private sector stakeholders view MaaS as a potential opportunity to explore such a business opportunity.

> *"We have announced our sustainability goals, which is to replace 1 million cars by 2030. So, that means 1 million passengers personally own cars. That's the sustainability goals that we are going after. Also, while doing it, we always try to compare our offering with the ownership of the car, because they are saying 96% sitting for at least here in the North region [are] rusting outside our doors. So why keep, why invest so many, so much money into an asset that is depreciating its value, rusting, and it's nothing for use? So we want to replace as many cars as possible with the other sustainable modes."* - WMS2 - MaaS Operator

> *"It would make sense because it would enable particularly carshare from a selfish perspective if you've got better links and better working with government, then it means you're more likely to get the vehicle spots that you want in sort of key locations because you know that they're going to grant you more vehicle permits to put your cars in sensitive locations to make it work with the environment [in] that trial. That's it from a selfish perspective."*- SMT6 - TSP

3. Identifying roles and responsibilities

Stakeholders of the *SMT* had a clear understanding of the roles and responsibilities of the other members. Consequently, they knew how their roles could affect other partners in performing the respective roles and eventually in achieving the end goal. This is partly due to the *appropriate project contract* which clearly defined the roles and responsibilities expected from each stakeholder. Further, the nature of the trial enabled round table discussions including the majority of the stakeholders creating an improved awareness about each other responsibilities and thereby facilitating *understanding among the stakeholders.*

> *"Yeah, I think that the contract that we have with X forced that as well as trying to work out who would pay for what? Because you have to work out who's funding what, who's doing what, and then you have to put all that into a contract, you're forced to work through those issues upfront, which is good."* - SMT10 - MaaS Operator

> *"I guess in this case, that would have been Q, which would handle those level one questions so that might be around payment or, you know, things that are unrelated to the actual development of the app. So, we generally allow the client to handle those level one and then if there are more technical issues, then we take them from the client, but we know you're right we do it for our own apps like first, we have our own app H. By H we directly communicate with the, with the user, for suggestions or issue reporting or something like that."* - SMT3 - App Developer

4. Identifying the conflicts

The inherent mismatch between the motives of the public and private sectors has resulted in several conflicts in the initial phases of the development of *WMS.* Although the top-level regulatory authorities were trying to create an open MaaS ecosystem the local authorities

had plans to develop their own MaaS solution centred around the public transport system. This led to self-centred negotiations making it difficult for the commercial players to arrive at a sensible agreement that satisfies the expectations of private-public actors' goals. However, *having a vision* for MaaS shaped through policies and legislation supported arriving at a common *understanding among the stakeholders.* Mladenović and Haavisto (2021) have highlighted such conflicts in MaaS ecosystems are healthy as opposed to the overemphasis on early consensus and avoiding confrontation as far as stakeholders embrace mutual respect.

> *"At least when it comes down to the public transportation, they are really afraid that they will lose the ownership of the customer, which, in my mind is a little bit outdated approach, because, in my view, no one can own the customer."* - WMS2 - MaaS Operator

> *"This again, is my personal impression, but I think if there is a problem, the main problem is economic. The operators obviously want to make a profit, which obviously they should, if I were an operator, I would sort of leverage to see which part of the cost the Public Authority will accept in their responsibility. And obviously, it's a point of negotiation I see as to how much you get and how much do I get. I think that is probably the main issue because I can't see a problem in integrating MaaS into the journey planner system."* - WMS4 - Regulatory Authority

> *"That's the view so when I say this MaaS and the cooperation, I see much more conflicts and things that are not that good cooperation. W also notify us [in case] some-service providers doesn't obey these obligations, and that's my view on these issues."* - WMS4 - Regulatory Authority

5. Managing expectations

The understanding of the organisational motives of different stakeholders led to a further level in the *SMT,* where they unconsciously managed the expectations among the stakeholders underpinned by mutual respect for each other's interests. This played an important role in the project as unexpected circumstances changed the direction and execution of the trial. In such instances, the stakeholders were consulted to evaluate how it affects them in terms of their resource commitments and objectives. This exercise played a key role in forming collaborative partnerships among the stakeholders.

"And you can't always outline the relationship you know how many times you're going to meet and things like that but I think it's just about managing people's expectations. I think that is really important because research can go off into various different directions that you haven't anticipated when starting a relationship with a partner." - SMT5 - MaaS Operator

6. Creating a level-playing field

Understanding among the stakeholders also assisted in *creating a level-playing field* in the *SMT*, that enabled different partners to harness their full potential. This means that the partners were allowed to contribute to the solution and provide their ideas to the round table. This may be due to the specific nature of the *SMT* where the project contract by iMOVE had given partners a similar voice when *defining the roles and responsibilities*. All the interviewees considered this a unique feature of the contract. *Creating a level-playing field* is one of the constructs that directly influenced building collaboration within the Sydney MaaS ecosystem.

"So yes, at some point in time we were sort of struggling, we didn't know where to go. And we gather in a big team, and we talk and we discuss, and at the end, everyone walked out of the room happy." - SMT1 - Research Coordinator

"So, I was really there to help all of the parties connect and to make sure research projects and contract was appropriate for all the parties involved." - SMT5 - MaaS Operator

7. Identifying synergies

A MaaS ecosystem is a product of all the stakeholders in its ecosystem. The awareness of the capabilities, role and motives were important in synchronising the expertise of one stakeholder with another in creating a synergised output. In *WMS,* this resulted in arriving at win-win solutions whereas in SMT this was one of the constructs that directly related to collaboration. The win-win solutions did not emerge in SMT as the stakeholders were already under the project contract.

"Discussing around, particularly the active one right [now], V [is] the first one in Australia, obviously trying to push reduction in vehicle ownership. I think there are obvious synergies there, you know, being involved in something like a MaaS trial, So one catch-up with q_2 *made sense for us to spend a bit of time and how we call*

this trial, essentially." - SMT6 - TSP

> *"And we have many partners and we kind of need these partner's collaboration to market our services efficiently. So, I think it's good if we think about the customer base of the xx. They live in the city, and they are probably not owning their car."* - WMS9 - TSP

In both cases, *understanding among the partners* resulted in *identifying the synergies* among each other. In the *SMT*, this construct emerged as an outcome of two other sub-constructs: *having a MaaS champion* and *having the right mix of partners* in addition to the *understanding among the partners.*

8. Having a MaaS champion

The S*MT* was initiated with the involvement of partners who had a passion for emerging transport solutions such as MaaS. However, the transformation of this passion into a workable solution was underpinned by having a stakeholder who is an expert in MaaS and on whom the other stakeholders could rely in the face of a challenge. Furthermore, stakeholders believe that the MaaS champion should possess a vision to guide other stakeholders through the various phases of development. In the case of the *SMT*, this role was played by *ITLS* specifically in harmonising partners into a common goal and in creating a glide path for the other partners. Recent literature has highlighted the importance of having a MaaS champion in navigating other stakeholders given the uncertainty involved in MaaS developments (Akse et al., 2023; Mulley and Nelson, 2020).

> *"And I have to say it first started when* y_2 *called me one day to say, we'd sort of known of his work he is done of us, he called me one day to say, "I think I've got an X project for you", which for us is basically the way we can do transport research. So it really started with a call from* y_2*. And then [we had] conversations with a number of stakeholders, not all of whom came through to the final collaboration, that changed quite substantially as we went along. But that was the start."* - SMT10 – MaaS Operator

9. Having the right mix of stakeholders

MaaS is an outcome of the integration of several stakeholder groups and hence if there are any issues in the service delivery of a stakeholder in a particular ecosystem it affects the delivery of the MaaS product. The initiators of *SMT* were cautious about selecting the right

mix of partners that they should integrate into the ecosystem. They have not only considered the recognition and expertise of the partner but also the ability of a particular partner to get along with other partners. In addition, *prior relationships* between the stakeholders played an important role in the selection process. The stakeholders who appeared to be dominating and uncooperative were excluded at the discussion stage.

> *"I think depending on who ends up being the owner of the MaaS platform will also influence how that works, because obviously if a government agency, for example, was the owner of this that has very different implications of how public transport and things would be involved in the app versus if it was a private entity that was developing a MaaS platform. I think it varies even on who is going to be leading and being that broker of that MaaS platform."* - SMT4 - Sponsor/Administrator

> *"At the end of the day, you wouldn't want your MaaS product to leave a gap in the mobility market. And when I'm talking about a gap, I'm talking about the different kinds of mobility services that you can find in local geographies. So let's talk about Sydney. If we are looking from the user point of view, you sort of seeking public transport service, trains and so forth, we see ride-hailing service to a traditional taxi, Uber, OLA, DiDi and the emerging services."*- SMT1 – Research Coordinator

> *"But it soon turned out that they're not only a partner, they're also very dominant, and there was a young lady, no criticism of her, who started telling us how the things were going to be run and she was going to control it and all this sort of stuff. And it became fairly clear as we started thinking about the requirements of X, which of course was the first time we did it, so we knew that it wasn't going to work."* - SMT8 - Research Coordinator

10. Finding win-win solutions

The proper understanding of the synergies and effective negotiation process has created win-win positions in the *WMS*. This was evident specifically in the case of negotiations conducted with *TSPs* who have found the sweet spot within their negotiation sessions. *Finding win-win positions* is also identified as a prerequisite for collaborative relationships among the stakeholders in *WMS* as it ensures that the objectives of all parties involved have been taken into consideration in arriving at the solution.

> *"On the markets where, you know when commercial players are not forced to have contracts with each other, it's sort of the market that could go in a way when such*

contracts were established, they are profitable. They are win-win contracts for both players." - WMS5 - Regulatory Authority

"For example, saying okay on Monday morning at eight o'clock we see that there's a quite many trips coming from this part of the city, so you should probably direct your taxis in that area if you want to have a ride. So, when they do that, they improve their service, and in return, they improve our service, and it's a win-win situation for us." - WMS2 - MaaS Operator

11. Understanding MaaS

Lack of understanding of the concept of MaaS among the stakeholders has been highlighted as a key factor that hinders collaboration in a particular MaaS scheme (Hensher et al., 2021c; Karlsson et al., 2020). This was addressed in the case of the *SMT* through informative sessions conducted at the initial stages of the trial with all the stakeholders to establish an understanding of the concept of MaaS. The sessions were continued throughout the trial by ITLS focusing on the purpose of the trial and the underlying reasons behind any changes. This understanding has been instrumental in *creating a common goal* within the ecosystem.

"Because it's just a good application that they [are] using. They are using Z's app, but they were not calling it H. I don't know what they're calling it. But I think that we are starting to see a very smart set of people within F maybe not as smart in E and the big difference is that the F team has a much greater respect for the entire ecosystem. Whereas I think E is still in love with the latest piece of technology to play with." - SMT8 - Research Coordinator

"...prior to the research trial that we did, a bunch of us from Q went through a presentation, Y was involved in, as we all heard, which was really interesting. So that sort of was my first, I guess, introduction to Y and y_2*. And since the MaaS trial, there is a Y email that went up about the presentations to attend and there's an ongoing sort of relationship that is broader than that trial, as well."* - SMT5 – MaaS Operator

12. Having a common goal

The partners in the *SMT* had a broad understanding of the purpose of this trial and, the ways, in which different partners can contribute toward that goal. This broad intention was

formally organised into workable goals and objectives through the iMOVE contract. This helped the stakeholders to progress smoothly throughout the trial period and collaborate effectively.

> *"So, there was always a goal of what we wanted to achieve at this and by running the trial, we didn't know what it would look like if it would work; if it would be a success if their research would say it's viable, we didn't know that, but we knew that this trial is successfully delivering was a goal. So, you have to go into the project, with a goal and goal. Otherwise, how do you know what you're achieving, or what you're striving towards."* - SMT4 - Sponsor/Administrator

> *"That was probably the reason why one party didn't continue because we didn't think that their aims and goals were aligned with the aims and goals of the rest of us and would have cost a lot of money. So, in that sense, you know, we kind of moved away from particular partnerships."* - SMT10 - MaaS Operator

13. Having a vision

Having a vision is essential when different stakeholders are working together to deliver a solution. The stakeholders of *WMS* believed that this should be set by the top-level regulatory authorities in collaboration with local councils. The initial conflicts between the private and public actors were a key reason that demonstrated the importance of *having a shared vision* among the stakeholders. Although it is adequate to have a common goal for a short-term project like *SMT*. However, for *WMS* given the ongoing interaction it has with the general public and transport networks, it is important to have a vision empowered by the regulatory authorities who overlook the transport landscape.

> *"So, the current minister [at] that time was, p [who] was very forward-thinking person, and also that resonated well with our current personnel in the ministry that we were trying to think how to take the next step in, transport policy, and some background for that was that we had to make quite impactful changes in our communication policy."* - WMS3 - Regulatory Authority

> *"But if the vision is unclear or some partner would like to control it, then we have an issue, even though it might be public transportation, it might be one of the MaaS operators, it might be one of the TSPs if they want to control it, then we have an issue. Openness on all sides, and trust that all of the partners would work towards*

the vision." - WMS2 - MaaS Operator

"The vision and regulations which should come from the city, where do they want or, how do they see the city, and people moving in it, let's say in 2030 or 2040. If they have a vision for that, then we can work together to get there. If the government or municipalities, cities don't have any visions, then it might become a little bit of a problem." - WMS2 - MaaS Operator

14. Enabling open MaaS ecosystems

Developing suitable legislation (which is recognised as a construct that forms trust) also facilitated the *enabling of open MaaS* ecosystems which supports the emergence of commercial MaaS operators in Finland. The regulations in Finland have favoured the market-driven MaaS model by opening up the market for all the players. This motivated the stakeholders within the *WMS* to design their relationships with stakeholders transparently with limited restrictions. On the other hand, the free-market ecosystems created improved quality standards and service levels given the availability of competing organisations to replace a given stakeholder in the MaaS ecosystem, specifically the TSPs and app developers.

"…. the beauty of the open ecosystem is that we don't have to worry about the service levels that much. Because if one of our partners is down, well we have four car rental partners for example if one of them is down we still have three to go. Same goes with the taxis we have three providers, if one is down, two will be still working. So that's also the beauty of the ecosystem if someone is down, the other ones will manage." - WMS2 - MaaS Operator

"I don't want to put this against each other, like you can only have one, one or the other. I think our stance has been that we want to make it possible for everyone to have the same opportunities and possibilities for everyone." - WMS3 - Regulatory Authority

"We were just one of the MaaS operators. It's an open competitive playground. We use the same, but even in, the Finnish environment, it is done in a way that all of those that you see the TSP over there, they have the same APIs and the same rules for anyone who wants to start on the B2C field." - WMS1- MaaS Operator

15. Negotiating openly

The open MaaS ecosystems ensure the negotiations among the stakeholders are conducted transparently without having exclusive deals with respective stakeholders belonging to a specific category. These types of negotiations are underpinned by the principles of an open MaaS ecosystem which are facilitated through legislation. However, in the initial phases, *WMS* suffered from the self-centred negotiations of the public and private stakeholders hindering its rapid expansion process although it was solved at a later stage.

> *"We've been pretty open towards the partners, relating the topic that we have more and we will not make any exclusive deals with anyone, because we do believe that in an open ecosystem, our partners [can] contribute to other ecosystems as well. We are not forcing any of the partners to make an exclusive deal with us, because we believe in the open ecosystem and the competitiveness that when there's competition, the end user is the one who benefits, and that will also push us to faster develop our services."* - WMS2 - MaaS Operator

> *"But when it was the obligation, there is a five-euro ticket A and they have to try to sell it which [is for] five euros to the end customer. Or if they're raising the price, it's much harder to sell if you know that it's usually five euros but A takes 5.50. So, this is why they are in some cases facing these obligations. But if they try to negotiate better terms for themselves, they have to go further. If you understand what I mean."* - WMS5 - Regulatory Authority

4.3 Outcomes of collaboration

Collaboration among the partners could lead to a conducive environment for MaaS development in multiple ways. The *SMT* experienced *working as a team, co-creation, developing together* and *extra commitment* as outcomes of collaboration. In *WMS*, *coopetition* and *overcoming barriers* emerged as outcomes of collaboration. *Continuous innovation* emerged as an outcome evident in both ecosystems. In Figure 4.3 and Figure 4.4, these are represented in green shades linked with the construct *collaboration.* This section initially describes the outcomes of collaboration that were evident in both cases and subsequently explains the outcomes exclusive to *SMT* and *WMS*.

1. Continuous innovation

The participants in both ecosystems have attempted to continuously innovate their MaaS solution in response to the observed behaviour patterns of the users. The rate of innovation

was high in the *SMT* due to the presence of a collaborative learning environment. It is important to note that the direction of the innovation was mostly driven by the motives of the leading stakeholders such as MaaS operators or investors. This is one reason for some of the criticisms related to the innovation trajectory of MaaS.

> *"A bit of iteration. Iteration is a fundamental principle of innovation. Where we iterated through MaaS models and MaaS design constellations. Have you seen any publicly available document where this has been documented? "We are now on the 17th iteration of the MaaS model and the constellation of actors" - No, we are not doing this because we're lacking the underlying innovation principle behind."* - WMS7 - University

> *"Yes, there's definitely room for innovation. The challenge may be that each company will do their innovations and they might not be thinking about the MaaS platforms, they think about their own service. As I mentioned, for example, this helmet box. It kind of appeared later on that (the app), we have this good thing but it's not comparable with the MaaS app. So, it's [common for] all the companies[that] are innovating themselves as mobility providers."* - SMT8 - TSP

2. Working as a team

The *SMT* encountered many challenges given that it was the first attempt at a MaaS trial in Australia. This created an experimental environment with frequent changes in schedules and plans in response to the challenges that *SMT* confronted. However, the stakeholders had taken participatory decisions on alternate paths which sometimes resulted in amendments to the initial intentions. In such instances, all stakeholders have worked as a team to execute the revised decisions taken in lieu of a dynamic environment. In the face of challenges, the stakeholders enhanced their contribution to the product to overcome the issues that could have not been solved as an individual organisation.

> *"I think everyone was in there with a common goal, everyone was really excited by this project and wanted to see it succeed. So, I think that's why it did succeed because everyone went in there willing to work together to make that work. So, from an X perspective, we've got over, 100 projects that we've been involved in various transport [research projects], and this is one of, as far as we're concerned, one of our success stories, because the teams do work so well together. They*

communicated very regularly; they were very integrated together as a team from both organizations worked team together." - SMT4 – Sponsor/Administrator

3. Co-creating

The stakeholders in the *SMT* have improved the MaaS product continuously by harmonising the individual partner capabilities in a complementary form. This *co-creation* is an outcome of collaborating with each other on designing and developing a MaaS product that cannot be developed on its own. Further, it enabled the partners to derive solutions using their best knowledge and they have attempted to develop and verify the functionalities which are unique to SMT.

> *"So, Z for example, they already have the available H app on which they gotta build extra functionality into the app to make the G service for us. What extra functionality they need to build basically being informed by Q and us. So we basically specify through the process of discussion, we know what feature is feasible within a timeline and budget and which feature is desirable, but not feasible, unfortunately, within the timeline and the budget."* - SMT1 – Research Coordinator

> *"Yeah and that's sort of on a broader picture, obviously on a more individualized picture we're interested in collaborating with both university, and commercial partners such as Q to understand, because you know their goal was to understand the viability of such a platform, and how MaaS would operate."* - SMT3 – App Developer

4. Developing together

The trial environment gave the space for the partners to improve their MaaS offering based on the learnings they received. These enabled the partners to derive solutions using their best knowledge and they have attempted to develop some functionalities with the assistance of other partners. This implicitly necessitated the stakeholders involved to be adequately competent to formulate real-world MaaS solutions. These perspectives have influenced them to improve their capabilities to deliver sustainable MaaS products.

> *"So, we were still learning ourselves, how to do it and we did learn a lot through working with Y and some of our other projects like our alpha assignment projects that were a lot more complicated than with Y. We learnt a lot from that and we're able to translate it into how we worked with Y."* - SMT5 - MaaS Operator

"...how MaaS would operate in Sydney and so we were also interested in participating and providing our expertise to, you know, to both sides and the parties, to enrich that research and push the agenda of Mobility as a Service as a viable option in Sydney and globally."- SMT3- App Developer

5. Going the extra mile

There were instances where the partners gave an additional commitment in the face of a challenging situation. This commitment may not be defined or stated in the contract explicitly although the partners went the extra mile when they felt the need. On the other hand, there are also instances where some of the partners have politely rejected the request for such an extra commitment when there is a lack of consensus among the partners in moving toward such an outcome.

"If you have a commercial loan, where you are seeing strategy development in the next 5-10 years, for example, you can justify the cost of investing in working with your transport provider, and partners in order to integrate them into your service." - SMT1 - Research Coordinator

"And Q actually sort of did a lot more than what most of our industry partners would have done in terms of the actual delivery. And I think part of that was purely to do with the fact that it was using the internal staff members as well and so it makes sense for them to do that." - SMT4 - Sponsor/Administrator

6. Coopetition

Coopetition refers to the act of cooperation between competing companies typically with the aim of achieving mutual benefits. This means that partners who may be competing with each other can get together in a competitive environment if their act of collaboration can result in benefits for both parties. The stakeholders in *WMS* demonstrated this understanding although they struggled to get competing stakeholders to a common platform at the beginning. Currently, *WMS* consists of competing TSPs who are collaborating on the same platform to share mutual benefits. Alternatively, coopetition is important when competing against the conventional mode of transport: the private car. The act of coopetition thrives when the stakeholder realises that existing challenges and threats cannot be dealt with only with their capabilities and resources.

"So that's the reason why some of the partners or at least most of the partners are working with us, because that's the thing (passenger car) that we are trying to compete with. And the only way to compete with the passenger car is to have an extensive collection of mobility because none of the modes themselves can do it. Public transportation cannot do it alone. Rental cars can't do it alone, micro-mobility can't do it alone." - WMS2 - MaaS Operator

"What comes to marketing? We are a small player even though S is quite a big brand and globally known. But we operate here in Finland as an individual company and of course, we get some support from the corporate but yeah, we have to survive on our own. We have many partners and we kind of we really need these partners' collaboration to market our services efficiently. So, I think it's a good if we think about the customer base of the W. They live in the city and they are probably not own car. So, we think that it's a good target group for us." - WMS9 - TSP

7. Finding means to overcome barriers

It was evident that all the stakeholders were working with each other in the face of challenges. Although there was a lot of hype around the MaaS the expansion of *WMS* is slow and stagnated compared to expected growth. This has even raised scepticism among certain TSPs who achieved faster growth, about retaining as a TSP in MaaS. Further, there were some conflicts between the public transport authority and MaaS operators at the initial stages which shifted the focus of *WMS* to solve such issues. However, with improved understanding over time, these partners have succeeded in delivering a comprehensive MaaS product.

"... it has been very slow and I'm a bit worried, to be honest, that it still has not reached that many cities. So like I say that two years ago, we were kind of hand in hand and we saw the added value." - WMS8 – TSP

4.4 Comparison between the two models

It is important to understand the key differences between the two conceptual models to investigate the underlying reasons for such deviations. Such an understanding would be beneficial in identifying the key implications for future MaaS developments. A summary of similarities and differences between the two models is provided in Table 4.3.

A thorough understanding of the contextual factors assists in interpreting differences between the constructs of the two models. In the *SMT*, the trial environment provided the flexibility to the partners to adapt according to their learning experiences and to explore new arenas building upon the ongoing experience. Most of the stakeholders joined the initiative with the societal motive to initiate a solution that forms sustainable travel patterns. In contrast, *WMS* is a commercial MaaS scheme and the expectations and the motives of the stakeholders in joining the scheme were underpinned by commercial interests except for the government agencies. *WMS* was continuously working on growth plans, strategies and ways to build an open environment that enables attracting more TSPs into the portfolio. Although the Finnish regulatory authorities favour the idea of MaaS, they intended it to be a standalone product that is not dependent on government subsidies. This interest led to the development of transport acts and regulations to enable open MaaS ecosystems. In New South Wales, at the time of the *SMT*, the regulators were adopting a passive approach towards the MaaS developments. Sydney had comparatively developed ICT infrastructure developers although the technological transformation was sluggish with respect to TSPs. In Helsinki, most of the TSPs were equipped with technological advancements that would enable them to integrate into intelligent transport solutions. This was partially due to the interoperable APIs enforced through the legislation. In both contexts, there was considerable interest from the users to participate in sustainable mobility solutions. The participants of the *SMT* were employees from IAG and this created an implicit obligation for the users to stay in until the end of the trial. In contrast for *WMS*, users are from the general public and they had to improve continuously to attract and retain customers.

Table 4.3: Comparison between the two models

Area	**Similarities**	**Differences**	
		Sydney MaaS Trial	**Whim MaaS Scheme**
Contextual factors	car-based mobility patterns, extensive PT network in cities	trial, passive involvement from regulatory authorities	commercial MaaS scheme, focused regulatory structure, growing micro-mobility use
Factors that lead to trust	capability of the partners	having prior relationships, creating accountability, communicating openly, appropriate contracting	developing suitable legislation, enforcing the regulations, complying with open data standards, having flexible contracts

Factors that lead to collaboration	understanding among the partners, recognising stakeholder motives, identifying synergies,	managing expectations, having a common goal, having a MaaS champion, understanding MaaS, having the right mix of partners, creating a level playing field, high emphasis on societal goals	identifying conflicts, enabling an open MaaS ecosystem, open negotiations, finding win-win positions, having a vision, high emphasis on commercial goals
Outcomes of collaboration	continuous innovation	developing together, co-creation, dedication, working as a team	findings mean to overcome barriers, coopetition

When comparing the constructs under *inter-organisational trust, the capability of the partners* emerged in both *SMT* and *WMS. Having prior relationships, open communication, appropriate contracting* and *creating accountability* were exclusive to *SMT*. In the case of *WMS, inter-organisation trust* is found to be influenced by developing *suitable legislation, enforcing the regulations, complying with open data standards and flexible contracts.* The process of *inter-organisation trust* was incremental in both cases. *WMS* adopted a market-driven approach where it is necessary for the stakeholders to be competent in their service delivery as there are replacements for most stakeholders in an open market. In the case of the *SMT,* the partners were selected based on prior relationships and recognition in their field of expertise and this process fostered trustworthy relationships among the stakeholders. Hence, the trust-building process is comparatively faster in *SMT* compared to *WMS* and this was crucial for *SMT* given the limited time frame of the project.

In both case studies, *inter-organisational trust* and *identifying synergies* emerged as prerequisites for collaborative partnerships among stakeholders. In the case of the *SMT, having a common goal, managing expectations* and *creating a level-playing field* emerged as the other prerequisites whereas in *WMS*, *having a vision* and *finding win-win positions* emerged as other prerequisites. *Understanding among the partners* emerged as a key construct in both models which facilitates *identifying synergies, managing expectations and creating a level-playing field.* In the *SMT*, it was evident that collaboration was the key success factor which led to the successful completion of the trial despite the unexpected challenges that the project team encountered throughout the project such as unexpected customer behaviour, continuous revisions that needed to be done to bundles and application, issues in payment integration, COVID pandemic etc. In *WMS*, although there

were some conflicts between the public sector and the MaaS operator in the beginning, *having a shared vision* enabled them to foster collaboration among the partners and to continue their strategic developments.

4.5 Conclusion

In line with the above discussion, it is evidenced that the MaaS developments have a considerable impact from the contextual factors. In a way, this emphasises the importance of studying MaaS developments in their contextual settings to understand more meaningful constructs behind trust and collaboration. It was evident that some of the constructs were common to both ecosystems despite the differences in their contextual settings. Although some constructs emerged in only one case, their significance cannot be underestimated. Hence, it was important to understand the applicability of the constructs that emerged in these two cases in the global context to verify the importance of constructs from a wider audience. Phase II of this study was planned mainly to achieve this purpose. Phase II was also intended to assist this study in arriving at a comprehensive understanding of the factors that led to trust and collaboration in a MaaS ecosystem. The next chapter presents the results and discussion of Phase II and the integration of the findings of Phase I and Phase II.

CHAPTER 5 FINDINGS AND DISCUSSION - PHASE II

This chapter presents the findings of the Phase II of this study. The chapter starts with a description of the analytical decisions (section 5.1) and section 5.2 explains the factors that emerged in Phase II, followed by an analysis of socio-demographics on these factors (section 5.3). Section 5.4 explains how these factors would play a role in building trust and collaboration within MaaS ecosystems. Subsequently, the findings of Phase I and Phase II were evaluated emphasising the similarities and differences to obtain a comprehensive understanding of the factors, constructs and their interrelationships in the formation of trust and collaboration (section 5.5). The chapter concludes with section 5.6 which explains the summary of integrated results from both phases.

5.1 Data Analysis

Data analysis was conducted with the *R* statistical package (Version 4.1.1; R Core Team, 2017). The packages used to conduct EFA include **psych** (Version 2.2.5), **ltm** (Version 0.1.7.4) and **EFA.dimensions** (Version 1.2.0). *R* is deemed to provide comprehensive packages for Exploratory Factor Analysis (EFA) among other open-source software packages (Izquierdo et al., 2014; Steine et al., 2021). Further, the availability of freely available learning and source materials on *R* makes it flexible to customise factor analysis based on user requirements. At the outset, the data was cleansed, structured and coded to facilitate the analysis of the data. Subsequently, the suitability of the data to conduct an EFA was evaluated prior to selecting a suitable factor extraction method. Next, the optimum number of factors was selected and extracted using the most appropriate Regularised Exploratory Factor Analysis (REFA). The below subsections explain each of these steps and the respective analytical decisions in detail.

5.1.1 Data Preparation

The first section of the survey questionnaire contained 9 questions related to the socio-demographics of participants and the second section consisted of 86 indicator variables categorised under 14 groups namely, role of trust, partner's capability, transparency and communication, mutual understanding, open data, prior relationships, MaaS contracts, regulatory environment, role of public transport authority, societal motives, identifying conflicts, TSP's perspective and outcomes of collaboration (see Appendix B). Of the 100 responses, 16 were missing more than 50% of the data and hence were removed. There

were three responses within the 80% - 90% completion range and these were retained after employing the mean imputation method to replace the missing responses. Studies on data imputation suggest that any imputation method is acceptable if only 5% of the overall data is missing and recommend using mean imputation if it is between 10%-15% (Schumacker and Lomax, 2016). The Likert scale data were coded with 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, to 5 = Strongly Agree. The socio-demographic variables were reviewed again to reassign some of the responses under other categories to either a new category or an existing category.

5.1.2 Sample Profile

The role of socio-demographics in shaping the stakeholder perspectives was evident in the previous studies conducted on MaaS ecosystems. The first section of the survey questionnaire was intended to capture socio-demographics including the organisation, level of employment, country of operation of the MaaS scheme and the interests of the different stakeholders within the ecosystem. The effect of these was examined to understand the composition of the sample.

All the participants were involved in a MaaS scheme directly or indirectly. Out of the 84 participants, 61 were either currently involved or have been involved in a MaaS scheme or MaaS pilot. As illustrated in Figure 5.1, the highest representation of Europe is probably due to the inclusion of first-mover nations of MaaS and unpinned by the increase in government-led initiatives to test MaaS schemes. In the case of Oceania, the reason for high representation would be partly due to the increasing number of MaaS trials conducted over the last five years. Further, the number of participants approached during the survey was higher in Oceania compared to other regions.

Table 5.1 summarises the organisations of the participants under three categories, namely private, public and research. The private sector accounted for 41%, the public sector for 13%, and the research community constituted 46%. The private sector participants include a myriad of stakeholder groups which is increasing with the upsurge of MaaS over the last couple of years. The last column specifies the country of the different organisation types to provide an overview of the representation.

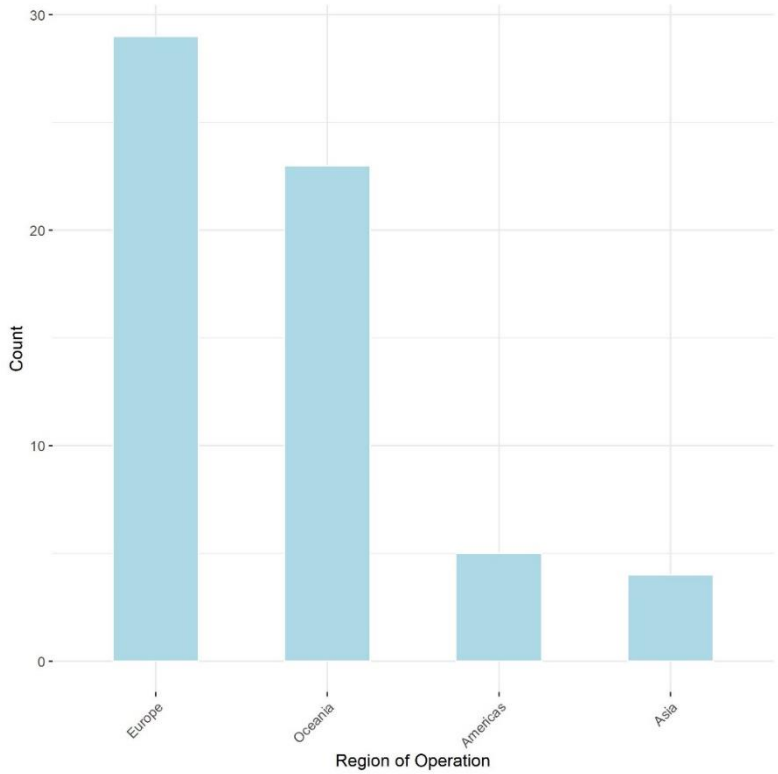

Figure 5.1: Region of MaaS operation

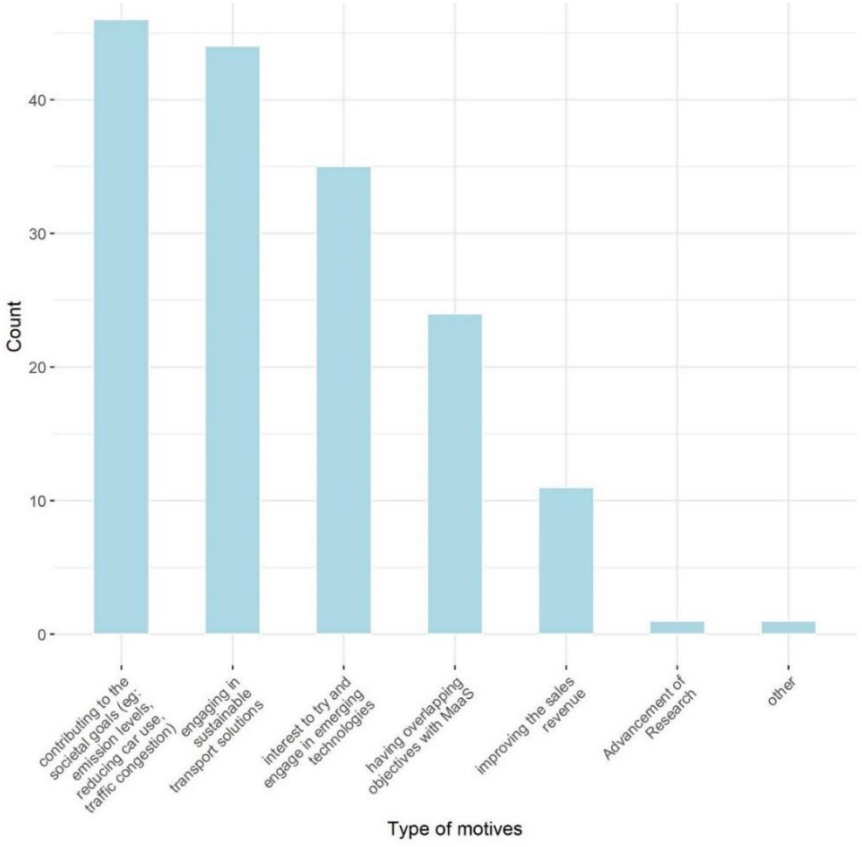

Figure 5.2: Motives of different stakeholders

Table 5.1: Composition of the participants' organisation

Sector	Organisation	Count	Country
Private (35)	Consultant	9	Australia (3), Canada (1), China (1), Indonesia (1), USA (3)
	Transport Service Provider	9	Australia (4), Finland (2), Japan (1), Switzerland (1), USA (1)
	App Developer	8	Australia (2), Canada (2), France (1), Finland (2), UK (1)
	Insurance Provider	3	Australia (3)
	Transport Infrastructure provider	2	Austria (2)
	International Transport Network	2	Australia (1), Belgium (1)
	ICT infrastructure provider	1	UK (1)
	MaaS Operator	1	Australia (1)
Public (11)	Regulatory Authority	10	Australia (8), Finland (2)
	Ministry	1	USA (1)
Research (39)	University	33	Australia (9), China (1), Finland (3), France (1), Germany (3), Greece (2), Italy (1), Japan (1), Luxembourg (1), Netherlands (1), Spain (1), UK(6), USA (1)
	Not-for-profit research and technology organisation	6	Australia (1), Finland (2), Sweden (1), UK (1), USA (1)

As evident in the literature review, stakeholder motives are considered one of the key determinants that shape a certain MaaS ecosystem. As shown in Figure 5.2, interest in societal goals (e.g., reducing emissions, shifting from car dependency, reducing traffic congestion) was the leading motive for joining MaaS for the majority of the participants followed by engaging in sustainable transport solutions and having mutual objectives with

MaaS. These motives coincided with the findings of Phase I and Phase II (refer to section 5.5.1) where societal motives and the emphasis on delivering societal goals emerged as strong themes.

5.1.3 Suitability of Data for EFA

The initial questionnaire contained 86 indicator variables which are listed in Table 3.3. This was reviewed again before the analysis to identify the variables that did not correlate well with the other variables. Further, some indicator variables were considered less relevant and resulted in complex loadings as described in section 5.1.7. Fifteen such variables were removed after investigating the inter-variable correlation, resulting in 71 variables to be considered in the EFA (Table 5.2). Pearson's correlation coefficient appeared to be inappropriate for the data due to the ordinal nature of the Likert-scaled items. This could violate both the assumptions of linearity and normality. Polychoric correlation is suggested in such cases given its ability to identify non-linear relationships and to recover the true factor model (Bandalos and Gerstner, 2016; Fabrigar et al., 1999; Finney and DiStefano, 2006; Izquierdo et al., 2014; Norris and Lecavalier, 2010; Watkins, 2018) . Drawing on these suggestions Polychoric correlation was used when assessing the relationships and for the input of EFA for the data in Phase II.

Cronbach's alpha of 0.905 indicated that the measures used in the study are comparatively reliable and consistent. The results of Bartlett's test of sphericity indicated that the correlation matrix was not random, $\chi^2(4067) = 3.4 \times 10^{-80}$, $p < .001$. Subsequently, the KMO statistic (Kaiser, 1974) was evaluated to check the sampling adequacy to conduct EFA which was required to be above a minimum of .50. Kaiser (1974) described KMO values as "in the .90s, marvellous; in the 80s, meritorious; in the .70s, middling; in the .60s, mediocre; in the .50s, miserable; below .50, unacceptable" (p. 35). In this analysis, the KMO statistic of 0.5 was deemed to meet the bare minimum requirement to perform the standard EFA although values > 0.7 is desired.

5.1.4 Choice of model fitting

The main intention of Phase II was to identify the latent factor structure and hence the Common Factor model (CFM) was selected over Principal Component Analysis (PCA) (Fabrigar et al., 1999; Watkins, 2018) with reference to the discussion under section 3.3.2. The CFM can be fitted to the data using multiple procedures. The most widely used

methods include principal axis factoring (PAF), Ordinary Least Square (OLS), MINRES and maximum likelihood (ML) factor analysis (Fabrigar and Wegener, 2012; Jung and Lee, 2011; Watkins, 2018). The selection of these methods is mainly based on the distributional properties of data, the nature of the theory and the sample adequacy. ML is based on the normal theory which is sensible to normality and usually requires larger sample sizes. In contrast, PAF, OLS and MINRES derive from the least square estimation technique and make no such distributional assumptions (Cudeck, 2000). Further, ML factor analysis develops initial communality estimates to intermediate estimates and these are iterated until a solution is reached which is a close fit to the measured correlation matrix (Norris and Lecavalier, 2010).

PAF can address the nonnormality of the data and recover weak factors compared to ML estimation methods (Briggs and MacCallum, 2003). The ML method has been widely recognised due to its ability to generate additional information such as model parameter standard errors, confidence intervals and significance tests (Cudeck and O'Dell, 1994), the likelihood test statistic and Root Mean Square Error of Approximation (RMSEA) (Browne and Cudeck, 1992; Steiger and Lind, 1980). The main drawback of ML opposed to other methods is the assumption of multivariate normality and less effectivity on recovering weak common factors. Further, it is more prone to converge on a solution prematurely than the other two methods.

Previous studies suggest that PAF outperforms ML in statistical simulations when factor loadings are weak (<0.40), sample sizes are small (< 300), multivariate normality is compromised and the number of factors is not accurately predicted (Briggs and MacCallum, 2003; MacCallum et al., 2001). Further, Briggs and MacCallum (2003) have recommended using PFA for factor analysis to increase the likelihood of recovering all the major factors. Additionally, it has been recommended to use a different estimation method to see whether the results converge (Gorsuch, 2014; Loehlin and Beaujean, 2017). Nevertheless, these problems are rare unless the data has serious violations pertaining to the assumptions of the CFM or ML fitting procedure. Although the ML method is considered slightly more accurate than the principal axis methods, it has been found that the difference in accuracy is marginal compared to sample size fluctuations in the case of small sample sizes (Browne, 1968). However, this becomes significant with larger sample

sizes and offsets the computational complexity involved with ML methods. Hence, the initial screening of the data is conducted to identify the distributional properties of the data.

The descriptive statistics of the data are presented in Figure 5.3 and Figure 5.4**Error! R eference source not found.** The univariate Skewness and the Kurtosis are within an approximately symmetric range with only 9 out of 71 variables falling within a moderately skewed range. Mardia's (1970) test statistic indicates that the multivariate Kurtosis is significant even though the Skewness is not significant ($p < .01$). This shows that the data does not hold the normality assumptions making ML estimation less suitable as the factor extraction method. Given the higher number of measured variables (71) compared to the sample size (84), the singularity checks of the sample covariance matrix (tolerance level = 1e-8) confirmed the matrix is approximately singular. Consequently, the other factor extraction method resulted in pre-mature solutions due to convergence issues. For these reasons, it was decided to search for a more robust method which could account for the singularity issues underpinned by the small sample size.

Jung and Takane (2008) introduced the Regularised Exploratory Factor Analysis (REFA) method based on the idea of generalised ridge regularisation which adds a regularisation penalty to the objective function, thereby constraining the magnitude of the factor loadings promoting the sparsity (presence of only a few important variables in each factor). REFA is recommended over the traditional estimation methods when the sample sizes are low and the sample covariance matrix is approximately singular (Jung and Lee, 2011). Further,

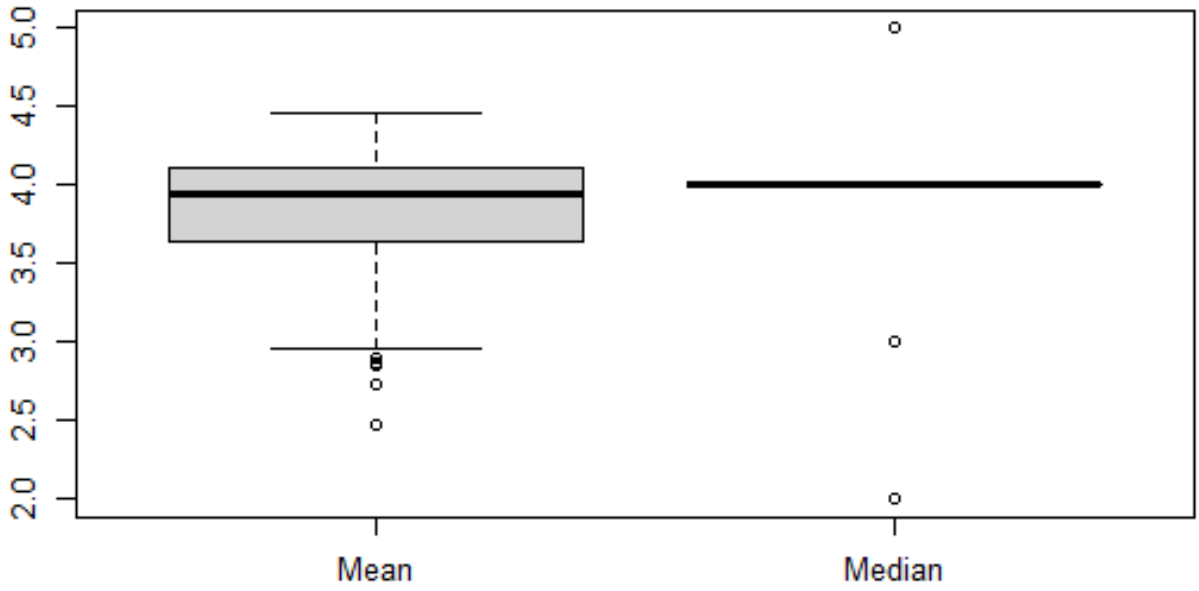

Figure 5.3: Boxplots of the distribution of means and medians of measured variables

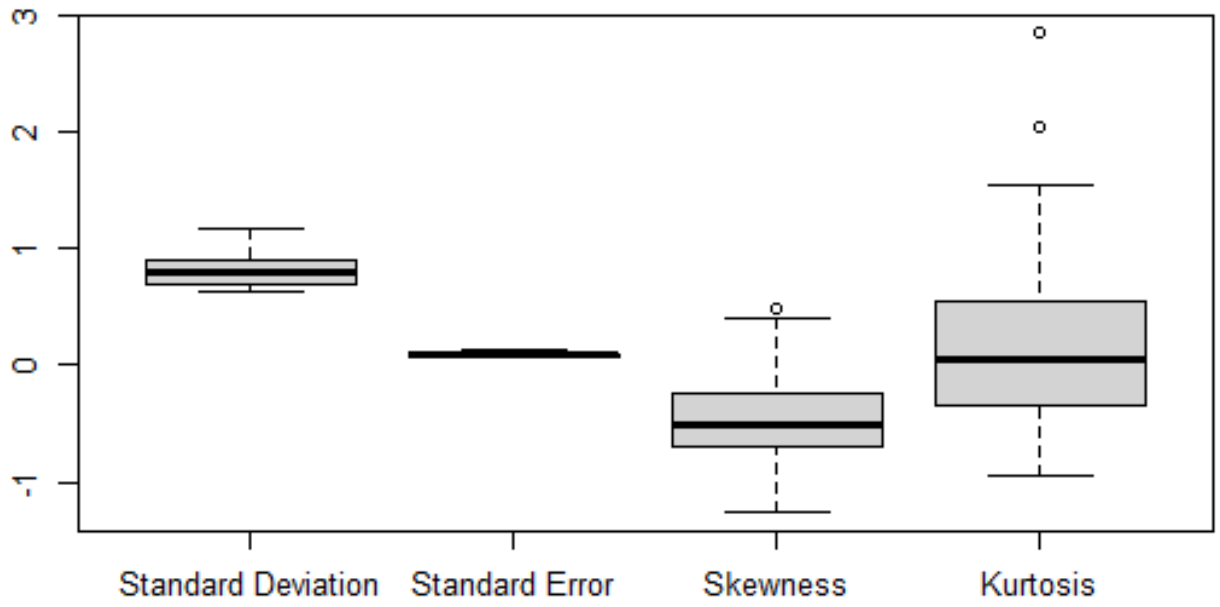

Figure 5.4: Boxplots of the distribution of SD, SE, Skew and Kurtosis of the measured variables

REFA is effective when there is a comparatively large set of measured variables which can lead to unstable factor loadings resulting in overfitting to the sample data. In addition, the regularisation term assists in selecting a smaller number of variables avoiding overfitting.

Consequently, REFA was selected as the most suitable method due to the stability and reliability of the method in the presence of low sampling adequacy. This low sampling adequacy is a result of the lower sample size compared to the number of measured variables. These conditions are prone to result in improper solutions when estimated using the standard EFA techniques mentioned above. The compromise of REFA is its ability to recover weak factors. The importance of identifying key factors was prioritised over weak factors given the possibility of identifying such factors in Phase I. Maximum Likelihood and least square estimations are the most prominent methods used in REFA (Jung and Lee, 2011). The regularised least square estimation is selected over regularised maximum likelihood estimation as the factoring method accounting for the non-normality of the data. However, the factor structures suggested by both methods were very similar except for the magnitude of the loading which was higher when using the regularised least square estimation method.

5.1.5 Factor selection

After selecting the factor analysis method, the next important step in this process is the selection of the optimum number of factors as this has a significant effect on the outcome.

The selection of the number of factors depends on two considerations, namely parsimony and plausibility. This study preferred to maintain a balance between the two aims as it is important to derive a model that explains the data with an adequate number of factors that may emerge from the analysis. Further, over-factoring is supported by literature compared to under-estimation of factors due to the potential false loadings that could occur from under-factoring. On the other hand, over-factoring can also result in extracting factors with little theoretical value. Although this study favoured a plausible approach, several techniques were used to determine the optimum number of factors. These include the Kaiser Criterion, MAP test, Visual scree plot and Parallel analysis. It is also possible to have a different number of factors to fit the same pattern of correlations and hence it is suggested to use cross-validation when selecting the appropriate number of factors (Haig, 2014).

Kaiser Criterion uses eigenvalues greater than one to determine the number of factors. The eigenvalues which are greater than 1 are decided as the factors. In line with this, it was suggested to extract 12 factors. Some studies have warned of the risk of only relying on this criterion as it often suggests an excessive number of factors compared to other methods (Izquierdo et al., 2014; Ruiz and San Martín, 1992). The scree test is also a similar technique that uses eigenvalues to determine the number of factors by plotting the eigenvalues of the correlation matrix in order and looking at the substantial drops. According to Figure 5.5, eight factors appeared to be suitable for the given dataset. This method has been debated as determining the substantial drop is subjective to the researcher.

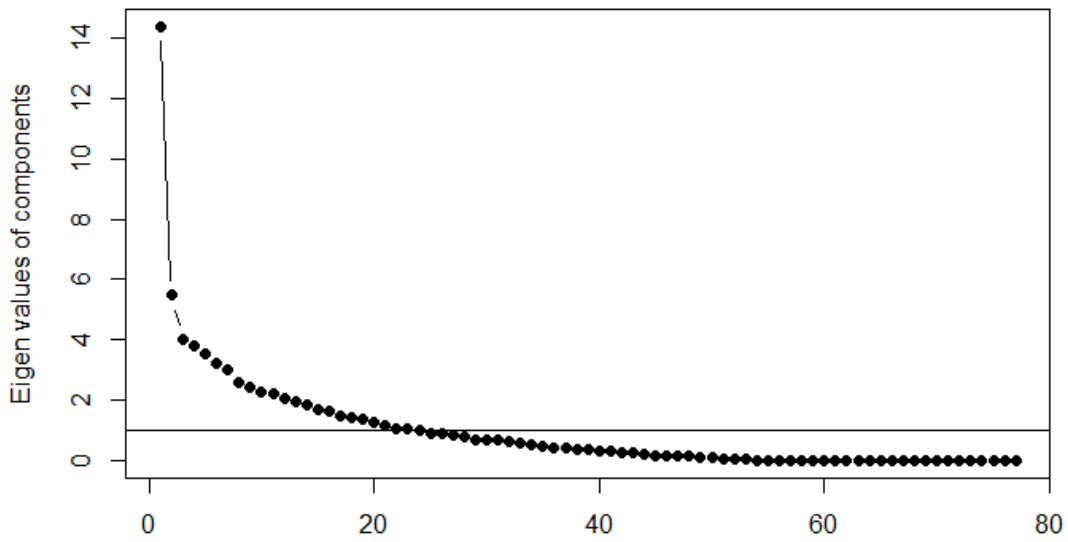

Figure 5.5: Scree plot of the data

The minimum average partial (MAP) test determines the number of factors by examining the correlation matrix for eigenvalues after partialling out the effect of the remaining factors. The test results for the data suggested retaining seven factors. Parallel Analysis is also another technique that uses eigenvalues derived from observed data and completely random data. Garrido et al. (2013) have illustrated the procedures for using Parallel Analysis and recommended its use with the Polychoric correlations when determining the dimensionality of the data. This method also suggested considering eight factors.

Velicer et al. (2000) recommended using Parallel Analysis, MAP and Visual Scree tests to decide on the number of factors to retain. Further, it is important to consider the interpretability and relevance of the factors when reaching a final decision. Based on the test results and the interpretability, eight factors were selected as the expected number of factors that need to be extracted using REFA. This judgement was supported by the parsimony and the conceptual models developed in Phase I. The resulting similarities and differences in factors extracted in Phase II were investigated to identify a set of generic factors that build trust and collaboration in a MaaS ecosystem.

5.1.6 Factor rotation

Factor rotation technique is the next important decision in the EFA. Orthogonal rotation and Oblique rotation are the two main divisions of rotational methods used. The orthogonal method assumes that the underlying common factors are uncorrelated with each other whereas oblique rotation allows for such correlations (Fabrigar and Wegener, 2012). The oblique rotation method was favoured over the orthogonal rotation method given that there is a considerable chance for the factors to be correlated (Brown, 2009; Gorsuch, 2014). Given the potential of observing correlations among the factors, Oblimin (under the Oblique family) rotation was used to determine the optimum factor structure for the model. Oblique rotation generates two types of factor loadings: structure and pattern coefficients. Structure coefficients represent correlations between measured variables and common factors. In contrast, pattern coefficients represent the partial regression coefficient which is derived after partialling out the influence of other common factors (Watkins, 2018). Numerous studies have recommended using pattern coefficients as the first focus of interpretation (Cudeck, 2000; Fabrigar and Wegener, 2012; Price, 2017; Watkins, 2018).

5.1.7 Determining the factor structure

The pattern coefficient of 0.40 was established for factor adequacy considering both statistical and practical significance. The initial iterations of the factor structures consisted of measured variables which demonstrated a pattern coefficient > 0.4 for more than one common factor resulting in complex loadings. The factor structures with such complex loadings were rejected and the resulting measured variables were either retained or removed to comply with a simple structure (Gorsuch, 2014; Thurstone, 1947; Watkins, 2018). The decision to remove or retain was informed by the domain expertise of the researcher, communality (h^2) and the importance of the respective measured variables (Fabrigar and Wegener, 2012; Watkins, 2018). The communality indicates the amount of variance of the measured variable explained by the common factor model. The EFA output was iterated until it conformed to a simple structure or until the complex loadings became interpretable. During these iterations, 14 factors were removed, namely Q12_3, Q15_1, Q13_6, Q16_5, Q19_5, Q19_6, Q21_2, Q21_3, Q21_5, Q22_1, Q23_4, Q24_1, Q24_2, Q24_5, Q13_2. The final factor structure is illustrated in Table 5.2 (refer to Table 3.3 for the measured variables represented by each code) highlighting the measured variables loaded under each factor. Out of 71 measured variables, 50 were loaded strongly (pattern coefficients > 0.40) on the extracted factors and this was considered adequate given the number of measured variables. Subsequently, the factors were labelled considering the measured variables which were loaded onto each factor, theoretical significance and the domain experience of the researcher (Fabrigar et al., 1999; Watkins, 2018).

Table 5.2: Factor pattern (loading) matrix

var	f1	f2	f3	f4	f5	f6	f7	f8	Communality (h2)
Q12_1	0.09	0.09	0.05	0.07	-0.02	-0.08	-0.09	0.51	0.33
Q12_2	-0.01	0.08	-0.03	0.16	-0.13	0.22	0.22	0.26	0.25
Q12_4	0.13	0.32	-0.02	-0.20	0.10	-0.11	0.56	0.10	0.56
Q13_1	-0.22	0.07	0.30	0.41	-0.19	-0.08	0.38	-0.07	0.49
Q13_3	-0.12	0.08	0.05	0.27	-0.14	-0.03	0.15	0.05	0.14
Q13_4	-0.20	0.17	-0.01	0.24	0.01	0.20	0.10	0.14	0.22
Q13_5	0.25	0.08	0.00	0.19	-0.06	0.07	0.15	0.17	0.23
Q14_1	-0.04	0.03	0.13	0.34	0.15	0.14	-0.22	0.38	0.41
Q14_2	0.01	0.20	0.12	0.03	-0.06	0.24	0.12	0.35	0.33
Q14_3	-0.10	0.05	0.12	-0.03	0.17	-0.02	0.27	0.59	0.57

var	f1	f2	f3	f4	f5	f6	f7	f8	Communality (h2)
Q14_4	0.17	0.09	0.13	-0.10	-0.07	0.05	0.15	0.63	0.56
Q15_2	0.00	0.22	-0.13	0.18	0.25	0.26	-0.18	0.13	0.30
Q15_3	-0.20	0.08	0.33	0.42	-0.16	0.25	0.15	-0.17	0.47
Q15_4	0.22	-0.25	0.13	0.10	-0.19	-0.05	0.01	-0.12	0.15
Q16_1	0.03	-0.02	0.55	0.02	0.20	-0.10	0.06	0.28	0.54
Q16_2	0.01	-0.11	0.52	0.02	0.24	0.21	0.10	0.23	0.57
Q16_3	0.07	0.07	0.41	-0.21	-0.15	0.06	0.08	-0.27	0.28
Q16_4	0.09	-0.05	-0.19	0.64	0.01	-0.20	0.08	0.12	0.47
Q17_1	0.06	0.53	0.07	-0.01	-0.28	0.12	0.25	0.00	0.46
Q17_2	0.23	-0.14	0.17	0.38	-0.07	-0.04	0.22	0.22	0.39
Q17_3	-0.16	0.28	0.07	0.47	0.09	-0.10	0.15	-0.09	0.39
Q17_4	-0.06	0.07	-0.06	0.05	0.18	-0.16	0.58	0.09	0.44
Q17_5	0.04	-0.31	0.01	0.18	0.16	-0.01	0.64	0.11	0.55
Q18_1	0.23	0.00	-0.19	-0.04	-0.35	0.03	0.29	0.21	0.31
Q18_2	-0.14	0.38	0.06	0.15	-0.20	0.22	0.07	-0.10	0.30
Q18_3	0.21	0.02	-0.10	0.62	0.13	0.08	-0.14	0.07	0.52
Q18_4	-0.02	0.19	0.10	0.42	-0.05	0.02	-0.30	0.30	0.44
Q19_1	0.09	0.17	0.36	0.04	0.32	-0.02	-0.17	0.19	0.44
Q19_2	0.00	0.01	0.80	-0.03	-0.06	-0.05	-0.02	0.00	0.62
Q19_3	-0.09	-0.07	0.79	-0.01	0.12	-0.03	-0.08	0.04	0.65
Q19_4	0.11	-0.21	0.37	0.25	0.29	0.05	0.15	0.08	0.45
Q20_1	0.07	0.08	0.41	-0.16	0.10	0.39	-0.02	0.10	0.45
Q20_2	0.27	0.02	0.11	0.22	0.32	0.08	0.04	-0.47	0.43
Q20_3	0.32	0.11	0.46	-0.04	0.04	-0.05	0.16	-0.08	0.44
Q20_4	0.54	0.12	0.16	0.01	-0.06	-0.04	-0.04	0.01	0.37
Q20_5	0.35	-0.02	-0.05	0.05	0.38	-0.18	0.34	0.02	0.48
Q20_6	0.18	0.19	0.02	0.44	-0.20	0.00	0.04	-0.02	0.35
Q21_1	0.16	0.27	0.21	0.09	0.07	-0.27	0.05	0.18	0.34
Q21_4	0.26	0.24	0.27	0.11	0.13	0.17	-0.21	-0.11	0.39
Q21_6	0.05	0.36	0.39	0.06	0.00	-0.47	0.06	0.04	0.52
Q22_2	0.04	0.27	0.03	0.42	0.10	0.03	0.09	-0.08	0.34
Q22_3	0.17	-0.05	0.05	0.00	-0.06	0.58	-0.22	0.01	0.42
Q22_4	0.16	0.01	-0.01	0.00	0.11	0.64	-0.18	0.16	0.53
Q22_5	0.17	0.02	0.25	0.22	-0.11	0.28	-0.09	0.42	0.51
Q23_1	0.08	0.05	0.15	0.02	0.47	0.25	0.23	-0.18	0.46
Q23_2	-0.15	0.17	0.23	-0.15	0.47	0.26	0.18	0.22	0.61
Q23_3	-0.05	0.13	0.05	0.03	0.68	0.06	0.08	0.05	0.55

var	f1	f2	f3	f4	f5	f6	f7	f8	Communality (h2)
Q24_3	0.35	0.01	0.09	-0.25	-0.34	0.11	0.04	-0.24	0.32
Q24_4	0.11	0.10	0.12	-0.05	0.72	-0.06	0.06	-0.08	0.65
Q24_6	0.32	0.08	0.11	0.25	0.14	-0.35	-0.24	0.11	0.39
Q24_7	0.39	0.02	-0.12	0.02	0.24	0.11	-0.01	-0.16	0.25
Q25_1	0.01	0.18	-0.10	0.14	0.06	0.52	0.36	-0.06	0.52
Q25_2	0.18	-0.04	0.06	0.18	-0.30	-0.13	0.15	-0.29	0.25
Q25_3	-0.32	0.47	-0.19	0.22	-0.22	0.16	-0.13	-0.07	0.48
Q25_4	-0.11	0.21	-0.11	0.21	-0.06	0.07	0.20	0.34	0.31
Q25_5	0.20	0.57	-0.16	0.01	-0.06	0.10	0.09	0.15	0.50
Q25_6	0.30	0.27	0.18	-0.10	-0.02	0.23	0.38	0.20	0.64
Q26_1	0.06	0.71	-0.05	0.02	0.15	0.05	0.03	0.09	0.62
Q26_2	0.16	0.69	-0.01	0.17	0.20	-0.12	-0.05	0.01	0.67
Q26_3	0.40	0.34	-0.08	-0.15	0.09	-0.09	-0.02	-0.01	0.33
Q26_4	-0.07	0.76	0.07	-0.05	0.08	-0.05	-0.08	0.03	0.59
Q27_1	-0.04	-0.02	-0.14	0.39	0.28	0.34	0.07	-0.13	0.36
Q27_2	0.06	0.07	-0.02	0.54	-0.16	0.29	0.01	-0.23	0.51
Q27_3	-0.04	-0.02	0.04	-0.03	0.27	-0.10	0.15	0.06	0.13
Q27_4	0.12	0.16	0.07	-0.03	0.02	-0.27	0.15	0.04	0.15
Q28_1	0.36	0.24	0.31	-0.07	0.24	0.00	-0.07	-0.12	0.46
Q28_2	0.55	0.02	0.23	0.00	0.00	0.24	0.26	-0.10	0.59
Q28_3	0.52	0.11	0.19	0.28	-0.18	0.15	-0.07	0.04	0.56
Q28_4	0.67	-0.04	0.14	0.11	0.00	0.06	0.02	0.06	0.54
Q28_5	0.53	0.06	-0.19	0.19	-0.12	0.07	0.00	0.39	0.59
Q28_6	0.76	0.09	-0.23	-0.02	0.12	0.01	0.02	0.02	0.65

5.2 Factors emerging from EFA

There were eight factors which emerged in the process of the analysis. These represent the underlying latent factors signified by the measured variables. The factors were named considering the indicator variables loaded under each factor. For identifying and naming the factors that emerged, the existing literature, the researchers' experience and findings from Phase I were used. The factors are briefly discussed in this section with reference to the measured variables. Sections 5.4 and 5.5 discuss the factors in detail compared with the extant literature and findings of Phase I.

Factor 1 – Understanding the need for collaboration

This factor recognised the importance of understanding the need for a collaborative effort from all the stakeholders. This emerged with the recognition of the expected outcomes of collaboration. The capability of generating new ideas, enhanced teamwork and investment in necessities required for collaboration were strongly loaded under this factor. Continuous innovation, coopetition and extra commitment demonstrated a moderate loading consistent with the findings of Phase I. All these measured variables emerged as constructs in Phase I except for the proactive actions from TSPs such as investing in necessary platforms and other required ICT infrastructure.

Measured Variable	Structure Coefficient	Description
Q28_6	0.76	Collaboration creates new solutions and ideas.
Q28_4	0.67	Collaboration can thrive in teamwork.
Q28_2	0.55	Continuous innovation is an output of collaboration.
Q20_4	0.54	Investing to develop a good API would be beneficial when joining MaaS.
Q28_5	0.53	Collaboration drives partners to provide extra commitment.
Q28_3	0.52	Collaboration can make competing partners work for a common goal.

Factor 2 – Developing open data standards

The measured variables loaded under this factor indicate the need for active involvement from regulatory authorities in setting up open data standards. The need to develop and enforce data standards was heavily loaded under this factor. Further, the loaded variables indicate the importance of the private sector playing a supportive role by developing compatible and user-friendly APIs. This comes with an understanding of the utility of MaaS as an effective sales channel for transport service providers. While enforcing open data standards may be initially criticised, it has been found to be effective in many contexts, particularly with the increasing interest in the sharing economy.

Measured Variable	Structure Coefficient	Description
Q19_2	0.80	Regulation should set open data standards.
Q19_3	0.79	Regulation should enforce open data standards.
Q16_1	0.55	All transport service providers should develop their APIs to be compatible with MaaS.
Q16_2	0.52	APIs should be both open and compatible to realize MaaS.
Q20_3	0.46	MaaS is an effective sales channel.

Q20_1	0.41	TSPs should open up their APIs to realise MaaS.
Q16_3	0.41	Open APIs are not a threat to data security.

Factor 3 - Need for a MaaS champion

This factor highlights the necessity of having a leading organisation or an individual for MaaS developments. This becomes important when facilitating collaboration among stakeholders in a dynamic and uncertain environment. Competency, experience in MaaS developments, prior relationships and the nature of the motives play an important role when performing as a MaaS champion. These capabilities are instrumental in identifying the synergies between the stakeholder organisations in the MaaS ecosystem to create win-win solutions.

Measured Variable	Structure Coefficient	Description
Q26_4	0.76	Some stakeholders are better at leading MaaS solutions given their role and exposure.
Q26_1	0.71	Collaboration in MaaS needs a leading organization.
Q26_2	0.69	There should be an organisation that connects all stakeholders together.
Q25_5	0.57	Identifying synergies creates win-win solutions.
Q17_1	0.53	Prior relationships are an added advantage in working with partners.
Q25_3	0.47	Some partners may be dominant given their roles in the ecosystem.

Factor 4 - Mutual understanding

The measured variables encapsulated under this factor suggest that the stakeholders in a MaaS ecosystem need to have an initial understanding of each other. This is a combined outcome of the understanding of the capabilities and motives of other partners. Moreover, identifying the role of different stakeholders within the ecosystem will improve the accountability of the partners. MaaS solutions mandate the partners to equip themselves with unique expertise which is required to deliver an effective product. The expertise that is expected by the other stakeholders depends on the role that a particular stakeholder plays in the MaaS ecosystem. This understanding helps to identify the synergies among the partners in delivering a particular MaaS product. Lack of shared understanding among the partners has been highlighted as a key factor that hinders collaboration in a particular MaaS scheme. Although there is a potential to have conflicting situations proper expectations management would assist stakeholders to proceed without elementary disputes. This

process involves engaging in discussions with the respective organizations to assess how the decisions have impacted their previous objectives. Subsequently, suitable remedies will be developed to compensate stakeholders who find themselves at a disadvantage.

Measured Variable	Structure Coefficient	Description
Q16_4	0.64	Opening the APIs depends on the nature of other partnering organizations.
Q18_3	0.62	Contracts create accountability.
Q27_2	0.54	Varying stakeholder motives can lead to conflicts.
Q17_3	0.47	Understanding the partner(s) before developing a business relationship is important.
Q20_6	0.44	MaaS objectives should align with the organizational motives of TSPs.
Q15_3	0.42	Expectations management should be a regular exercise in MaaS developments.
Q22_2	0.42	There should be synergies between partners to collaborate with each other.
Q18_4	0.42	Clearly defined roles and responsibilities for a partner improve their accountability.
Q13_1	0.41	Organizations should consider the reputation of the partners before entering into MaaS partnerships.

Factor 5 – Emphasis on societal motives

The indicator variables loaded under this factor denote the importance of integrating societal goals into MaaS products. The measured variables with strong loadings advocate subsidising MaaS at least for the societal benefits that it delivers. The metrics to measure the societal benefits are still under debate and recently Hensher et al. (2023) have suggested a structured mechanism to reward MaaS operators for achieving societal goals. It is important to note that the intended societal goals may differ based on the geographic jurisdictions. Even though the indicator variables suggested prioritising societal motives, attaining this would be an arduous task in a purely commercially driven MaaS model. Alternatively, TSPs can contribute to this process by providing discounts to make the offer attractive to the customers specifically to develop more sustainable bundle choices. It would be challenging to strike a balance between societal and commercial motives at the initial stages of the product and in that stage, it would be useful to have financial support from the authorities who advocate sustainable travel behaviour.

Measured Variable	Structure Coefficient	Description
Q24_4	0.72	Government should subsidise MaaS in return for the societal benefits it receives.
Q23_3	0.68	The government needs to subsidise the MaaS developments considering the societal goals that it delivers.
Q23_2	0.47	Societal motives should stay on top of commercial motives.
Q23_1	0.47	The main aim of MaaS is societal motives.

Factor 6 – Coopetition

Coopetition refers to the act of cooperation between competing companies typically with the aim of achieving mutual benefits. The measured variables indicated that understanding the dynamics of coopetition is beneficial for MaaS developments. There could be potential conflicts due to the inherent differences among the companies, but it is essential to find the sweet spot to develop a comprehensive MaaS solution that includes a variety of transport modalities. The PTA-driven MaaS appears to have a negative loading on coopetition, probably due to the negotiating power and influence that it has over the other TSPs which could hamper the negotiation process. In contrast, the commercial MaaS schemes may have a better chance of achieving coopetition as evident in the *Whim MaaS scheme*. Some stakeholders indicated the importance of PTA playing a role in MaaS as a TSP although it was not preferred to have PTA as the MaaS operator.

Measured Variable	Structure Coefficient	Description
Q22_4	0.64	Collaborating with competitors can be beneficial.
Q22_3	0.58	Competing TSPs could collaborate on the same platform.
Q25_1	0.52	Partners should be aware of the motives of other partners.
Q21_6	-0.47	If PTA runs MaaS it creates more confidence among stakeholders.

Factor 7 – Prior relationships

This factor indicates the importance of having prior relationships with other partners in the ecosystem. According to the literature, trust is built gradually and requires mutual actions, rather than being established suddenly or in a one-sided manner. Further, as evident in the findings of Phase I, organisations prefer working with an unknown organisation based on a referral of one of their partner organisations. This referral trust can make the process of

building trust faster in some cases. The relationship can either be commercial or non-commercial or even could be at an individual level.

Measured Variable	Structure Coefficient	Description
Q17_5	0.64	Prior relationships need to have a considerable temporal history.
Q17_4	0.58	Prior relationship with the partner is needed to build trust.
Q12_4	0.56	Recommendation on a new partner from an existing partner is essential when entering into MaaS agreements.

Factor 8 – Transparent agreements

Transparency is an important aspect of any ecosystem. Transparency within the ecosystem and the agreements are highlighted as a sub-theme under the nature of the contract in Phase I. This includes the agreements that the MaaS operator has with the TSPs, app developers and other stakeholders. Further, it is necessary to inform and update the stakeholders about the latest decisions and the strategic direction of the MaaS scheme. The contracts need to be adequately flexible and staggered such that changes are accommodated based on the circumstances and developments. This includes negotiable terms and conditions which are discussed openly among the agreed parties. The flexibility of the contract is appreciated given the nature of the solutions such as MaaS which has an evolutionary process.

Measured Variable	Structure Coefficient	Description
Q14_4	0.63	Data and information about the MaaS scheme should be available to all the partners.
Q14_3	0.59	Agreements among the partners should be visible to all stakeholders.
Q12_1	0.51	All the terms and conditions should be explicitly stated in all contractual agreements.
Q20_2	-0.47	Increasing volume is the main motive of TSPs.
Q22_5	0.42	Collaboration would allow firms to go beyond the contractual obligations.

5.3 Effect of sociodemographic on the EFA Model

It is appealing to understand whether there would be an impact on the latent factors from the socio-demographic variables (Section 5.1.2) which were not included as measured variables in the EFA. The variables that captured the social-demographic data of the participants were considered for this analysis, namely *organisation, level of employment*

and the *country of MaaS operation*. Although these are categorical variables, they were further divided into subcategories as the higher number of categories resulted in an inadequate number of responses under each category. The *level of employment* was not sub-categorised as it had only 5 levels. The variable *organisation* was categorised into regulatory and non-regulatory as both the literature and the findings of this research indicated that there could be varying opinions among the stakeholders belonging to these stakeholder groups. The *Country of MaaS operation* was categorised under the respective continents given the difference between the level of development and nature of the MaaS schemes in different continents. The respective variables and the categories are presented in Table 5.3.

To explore the influence of socio-demographics on the latent factors, these variables were included directly in the EFA by introducing an interacting variable to represent the responses of each category; however, due to small sample sizes, the results of the estimated EFA models were distorted. Thus, an alternative approach was used in which the factor scores of each variable were compared against the different categories using appropriate statistical tests. The subsequent paragraphs explain each of these methods, statistical tests and results in detail.

Table 5.3: Sub-categories of the selected contextual variables

Variable	Subcategories	Details
Organisation	Regulatory	Public Transport Authority, Ministry, Regulatory Authority
	Non-regulatory	Transport Infrastructure provider, App Developer, Consultant, ICT infrastructure provider, Insurance Provider, International Transport Network, MaaS Operator, Transport Service Provider
Country of MaaS operation	Oceania, Asia, South America, Europe, Africa	Default
Level of Employment	Director, Top Management, Manager, Researcher, Executive, Supervisor	Default

In the first attempt, the mean difference between the subcategories of the measured variables loaded onto each factor was examined to identify the variables where there are significant differences in the means. The measured variables with a significant difference are split into two interaction variables, indicating which responses (to a statement) belong to what category (of the responses). As an example, the statement Q26_1 interacted with the respondent organisation, resulting in two interaction variables, namely Q26_1**R** and Q26_1**NR** where the former represents the regulatory respondent's responses to the statement Q26_1 while the latter indicates responses to the same statement from non-regulatory responses. These two interaction variables replaced the original Q26_1 and a separate EFA model was estimated. The loading of the modified variables in the resulting model was examined against the initial model to understand the differences. The loadings indicated a comparatively different pattern with complex loadings. This was mainly due to the change in correlations resulting from the modified variables. Hence, it was decided to use a more statistically robust method to capture the effects of such differences.

Accordingly, a follow-up analysis was conducted by calculating a factor score for each participant using the factor loadings under each factor. For example, the factor score for F1 for a particular participant was calculated by multiplying the factor loading of each measured variable with the respective Likert scale response of that participant. The factor scores were then used to evaluate whether there is a significant difference among socio-demographic categories presented in Table 5.3. The Kruskal-Wallis (Kruskal and Wallis, 1952) and Wilcoxon rank (Wilcoxon, 1945) tests were used to test the significance of the categorical variables. They are non-parametric statistical tests used to compare groups of data that do not meet the assumptions of normality or equal variances required by parametric tests such as t-tests or ANOVA. The Kruskal-Wallis test is used for comparing three or more independent groups, while the Wilcoxon rank test is used for comparing two independent groups.

Accordingly, the Wilcoxon rank test was used to test the differences between Regulatory and Non-regulatory categories. The test results are provided in Table 5.4. The test results were significant (at a 5% significance level) only for *Mutual understanding (F4)*. This indicates that there is a significant difference between the median values of regulatory and non-regulatory categories for the *F4* factor score. The Kruskal-Wallis test was used to evaluate the categorical differences in the level of employment and the region of MaaS operation as they had more than two different categories. The test results for the level of

employment were non-significant across all the factors for the level of employment (refer to Table 5.4).

The test result for the region of MaaS operation was significant (5% significance level) for *understanding the need for collaboration (F1)*. This indicates that the factor scores for the *F1* were significantly different among the regions of the MaaS operation. This was further analysed using Dunn's pairwise test with Bonferroni adjustment to investigate the differences between two continents at a time. The results of these statistical tests are indicated in Table 5.5. The test result indicates that there is a significant difference between the factor scores between Europe and America for understanding the need for collaboration (F1).

Table 5.4: Results of the statistical tests

Factor	H_0	Statistical test	P-value
F1	There exists a significant difference in the factor scores of F1 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.6082
F2	There exists a significant difference in the factor scores of F2 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.6139
F3	There exists a significant difference in the factor scores of F3 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.3200
F4	There exists a significant difference in the factor scores of F4 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.0263
F5	There exists a significant difference in the factor scores of F5 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.2348
F6	There exists a significant difference in the factor scores of F6 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.3232
F7	There exists a significant difference in the factor scores of F7 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.2369
F8	There exists a significant difference in the factor scores of F8 between regulatory and non-regulatory organizations.	Wilcoxon rank test	0.6853
F1	There exists a significant difference in the factor scores of F1 among the levels of employment.	Kruskal-Wallis	0.4964

Factor	H_0	Statistical test	P-value
F2	There exists a significant difference in the factor scores of F2 among the levels of employment.	Kruskal-Wallis	0.3760
F3	There exists a significant difference in the factor scores of F3 among the levels of employment.	Kruskal-Wallis	0.8224
F4	There exists a significant difference in the factor scores of F4 among the levels of employment.	Kruskal-Wallis	0.5196
F5	There exists a significant difference in the factor scores of F5 among the levels of employment.	Kruskal-Wallis	0.6905
F6	There exists a significant difference in the factor scores of F6 among the levels of employment.	Kruskal-Wallis	0.1260
F7	There exists a significant difference in the factor scores of F7 among the levels of employment.	Kruskal-Wallis	0.3403
F8	There exists a significant difference in the factor scores of F8 among the levels of employment.	Kruskal-Wallis	0.4071
F1	There exists a significant difference in the factor scores of F1 among the continents of the MaaS operation.	Kruskal-Wallis	0.0296
F2	There exists a significant difference in the factor scores of F2 among the continents of the MaaS operation.	Kruskal-Wallis	0.5638
F3	There exists a significant difference in the factor scores of F3 among the continents of the MaaS operation.	Kruskal-Wallis	0.6242
F4	There exists a significant difference in the factor scores of F4 among the continents of the MaaS operation	Kruskal-Wallis	0.1429
F5	There exists a significant difference in the factor scores of F5 among the continents of the MaaS operation.	Kruskal-Wallis	0.4277
F6	There exists a significant difference in the factor scores of F6 among the continents of the MaaS operation.	Kruskal-Wallis	0.4187
F7	There exists a significant difference in the factor scores of F7 among the continents of the MaaS operation.	Kruskal-Wallis	0.7706
F8	There exists a significant difference in the factor scores of F8 among the continents of MaaS operation.	Kruskal-Wallis	0.2129

Table 5.5: Results of Dunn's pairwise test with Bonferroni correction

Factor	H_0	Statistical test	P-value
F1	There exists a significant difference in the factor scores of F1 between Asia and America.	Dunn's pairwise test with Bonferroni correction	0.2393
F1	There exists a significant difference in the factor scores of F1 between Asia and Europe.	Dunn's pairwise test with Bonferroni correction	1.000
F1	There exists a significant difference in the factor scores of F1 between Asia and America.	Dunn's pairwise test with Bonferroni correction	0.0113
F1	There exists a significant difference in the factor scores of F1 between Oceania and America.	Dunn's pairwise test with Bonferroni correction	0.1322
F1	There exists a significant difference in the factor scores of F1 between Asia and America.	Dunn's pairwise test with Bonferroni correction	1.000
F1	There exists a significant difference in the factor scores of F1 between Oceania and Europe.	Dunn's pairwise test with Bonferroni correction	0.4267

5.4 Discussion on the factors

It is important to understand how the eight factors that emerged from the EFA (Section 5.2) can induce trust and collaboration within a MaaS ecosystem. The eight factors that emerged in the process of analysis are categorised under trust-related and collaboration-related to discuss and compare the factors in a structured manner. Table 5.6 illustrates the categorisation of the factors.

Table 5.6: Categorisation of the common factors

Trust related	Collaboration related
Creating open data standards (F2)	Understanding the need for collaboration (F1)
Transparent agreements (F8)	Need for MaaS Champion (F3)
Prior relationships (F7)	Mutual understanding (F4)
	Emphasis on societal motives (F5)
	Coopetition (F6)

5.4.1 Factors related to trust

The factors included in this sub-section are related to building trust within the ecosystem. The indicator variables under *creating open data standards (F2)* emphasise the need for developing open data standards. It is important to develop open data standards as it facilitates integration among the stakeholders and creates opportunities for potential MaaS operators to enter the market. However, this needs to be complemented by the practices of the private sector by developing compatible and user-friendly APIs. Further, it is important to maintain responsible behaviour such as not exploiting the information acquired through stakeholders.

Prior relationships (F7) and *transparent agreements (F8)* are other factors that could induce trusting relationships within the ecosystem. The accountability of the other stakeholders is highly uncertain specifically in an environment where they haven't had prior relationships. The prior relationships provide an understanding of the partner and hence assist in entering into more effective and efficient relationships. *Transparent agreements* refer to the openness of the agreements and the importance of shared information within the ecosystem. Since MaaS is still at the stage of development the majority of the stakeholders probably join the system with a lack of understanding of the concept of MaaS. This will restrain them from entering into agreements that have rigid rules, regulations and exclusive deals.

5.4.2 Factors related to collaboration

This sub-section discusses the factors which are useful in building a collaborative environment. The nature of the stakeholder interrelationships plays a vital role in building long-term relationships. This is influenced by the understanding among the stakeholders about the need to collaborate. *Understanding the need for collaboration (F1)* highlights the importance of understanding the outcomes of collaboration within a MaaS ecosystem. It is important to realise that it is unlikely to realise MaaS only with the capabilities of one organisation. Such awareness occurs with an understanding of the benefits of collaborating. Moreover, it is vital to have a *mutual understanding (F4)* among the stakeholders within the ecosystems about their capabilities, motives and synergies. This helps to identify win-win solutions and to find the sweet spot that facilitates collaboration. Finding win-win solutions becomes efficient with the *inclusion of a MaaS champion (F3)* who will assist in providing direction and improvements to the MaaS product informed by the vision for

MaaS. The organisation or the individual who plays the role of MaaS champion does not necessarily have to lead the MaaS ecosystem, yet their expertise would help to effectively overcome barriers and to improve continuously.

Both private and public sector actors had a common consensus on the importance of societal goals. The pursuit of societal goals and the role of regulatory authorities in achieving those goals are heavily debated topics. The measured variables under *emphasis on societal motives (F5)* favoured an increased emphasis on societal motives. The societal motives reflect the importance of MaaS being aimed at achieving sustainable travel behaviour and thereby reducing emissions and traffic congestion levels. Further, the measured variables suggest the need for regulatory authorities to subsidise MaaS developments. The quantification of the societal benefits still requires further research although the MaaS operators are increasingly arguing for subsidisation schemes for MaaS claiming the capability of producing societal benefits. The implication of these findings to policy developments is discussed in detail under section 6.1.

Coopetition (F6) becomes important in the context of MaaS as it cannot be realised with the involvement of only one stakeholder. The users will only subscribe to MaaS if it provides a value-added compared to the status quo. *Coopetition (F6)* helps to build comprehensive MaaS solutions where users can find most of the transport options that they typically use. Even though the MaaS solutions operated by a PTA are indicated as a deterrence (probably due to the bureaucracy involved with public agencies), the importance of the PTA being an active stakeholder cannot be neglected. This is mainly due to the existing user base and the control it has over the mass public transport network of a particular jurisdiction. This will benefit the members of the ecosystem in the long run when scaling up the MaaS solution.

It is worthwhile to investigate whether there is a significant effect of socio-demographic variables on the factors identified. The sociodemographic analysis investigated the influences of socio-demographics on a certain factor. As detailed in section 5.3 the sociodemographic analysis was conducted for variables namely, l*evel of employment, organisation type* and *the region of MaaS operation*. The analysis indicated significant results only in the case of *organisation type* and the *region of operation* and also only for one factor each namely, *mutual understanding (F4)* and *understanding the need for collaboration (F1)* respectively. However, the finding of Phase I indicated a significant

influence of the context in building trust and collaboration in MaaS ecosystems. This mismatch is probably due to the capability of qualitative methods to provide a more detailed and interpretive understanding of the interrelationships between the factors and their situational context. The next section attempts to complement the findings of Phase I and Phase II with the intention of developing a holistic representation of the formation of trust and collaboration.

5.5 Integration of the findings of Phase I and Phase II

This section includes a comparison between the findings of Phase I and Phase II and subsequently presents a discussion on the reasons for any deviations. This uses the factors that emerged in the two phases to demonstrate a comprehensive understanding and to suggest some fundamental factors that may lead toward a collaborative environment in any context. The extant literature and the experience of the researcher have also been used in conducting this evaluation.

5.5.1 Similarities between Phase I and Phase II

Understanding the similarities between the two models would be an appropriate point of departure for integrating the findings of the two Phases. Table 5.7 provides a summary of factors that appeared in both Phases. The factors under Phase II have limited reference to the contextual factors as the measured variables are directly aimed at measuring the factors that lead to trust and collaboration and the respective outcomes.

The factors related to trust in Phase II include *developing open data standards (F2)*, *prior relationships (F7)* and *transparent agreements (F8)*. Constructs related to trust in Phase I overlap with these factors and the measured variables. The measured variables under *F2* specify the need for regulatory authorities to initiate and develop open data standards. The open data standards have been indicated as a prerequisite in MaaS readiness indices such as CIVITAS ECCENTRIC (2017) and UCL (2020). Open data regulation was identified as a factor in both Phases, but in Phase II this was revealed further where it necessitated the importance of TSPs to not only open their APIs but also to make them compatible (Arias-Molinares and García-Palomares, 2020; Hietanen, 2023) such that stakeholders can smoothly integrate with each other's systems and platforms. Open data standards become mandatory even in a blockchain-based MaaS model which can arguably be operated without stakeholder trust (Chinaei et al., 2022).

Prior relationships (F7) and *transparent agreements (F8)* are other factors that emerged in Phase II under trust-related factors. This provides a similar meaning to Phase I constructs *appropriate agreements, accountability* and *flexible contracts.* Hence, stakeholders should be cautious not to create contracts with exhaustive clauses that would impede the effectiveness of the relationship. Transparency and openness may lead to improved levels of trust thereby ensuring cooperative relationships. This provides some answers to the questions elevated by Mulley and Nelson (2020) regarding the terms of the contract. Further, the need for open and flexible contracts has been favoured over the rigid performance contracts by van den Hurk et al. (2021) based on a study conducted in Merwede, Utrecht regarding shared mobility platforms in MaaS ecosystems. In Phase I, flexible and open contract formation was observed in Whim as a result of legislative enforcement where stakeholders were left to collaborate in an open ecosystem. In both the Sydney MaaS trial and the Whim MaaS scheme, stakeholders identified the need to have flexible, transparent and staggered contracts. Prior relationships emerged as an essential construct for trust in both Phases. However, this only emerged in the Sydney MaaS trial in Phase I. This is probably due to the partner selection process that was inculcated in the two case studies. In the Sydney MaaS trial, prior relationships and the recognition of the partners played an important role in the partner selection process. This construct does not appear in Whim MaaS schemes as they were selecting partners in a fairly open ecosystem.

The factor *understanding the need for collaboration (F1)* covered all the constructs that emerged in Phase I as the outcomes of collaboration. Although many studies have highlighted the benefits of collaboration (Gonzalez-Feliu et al., 2018; Guyader et al., 2021), the importance of the awareness of collaboration in MaaS is only addressed by industry practitioners (Hietanen, 2023). This was further recognised through the measured variables included under *Coopetition (F6)*. This can be seen as a case where the two Phases completely reflected the findings of one another. It is natural to observe conflicts among stakeholders with varying motives working with each other. The inherent differences between the private and public sectors further the likelihood of conflicts within the MaaS ecosystem.

Need for a MaaS champion (F3) emerged in both phases although in Phase I this was attributed only to the Sydney MaaS trial. The role of the MaaS champion has many overlaps with the Intermediary Mobility Integrators (IMI) proposed by Smith et al. (2020) apart from the involvement in admin and contract management tasks. The study suggests either a

private or public actor who is impartial and capable of performing this task. Hensher et al. (2021c) advocate the importance of having a MaaS champion who will accelerate the MaaS developments while achieving societal goals. The authors propose a government stakeholder to play the role of a MaaS champion. However, both ecosystems in Phase I had a private actor playing the role of the MaaS champion who navigated the stakeholders to develop effective MaaS solutions. Even though the need for a MaaS champion does not emerge as a construct in the Whim MaaS scheme, the strategic planning of MaaS Global was instrumental in sustaining the MaaS product in challenging situations. However, MaaS Global can be considered a MaaS champion in the Whim MaaS ecosystem even though their key role is the MaaS operator.

Mutual understanding (F4) highlighted the importance of mutual understanding among the partners, and this captured construct emerged in Phase I as *identifying stakeholder objectives, identifying synergies* and *expectations management.* Specifically, mutual understanding helps in identifying the synergies between the private and public sectors which is necessary for developing comprehensive MaaS schemes (Sochor et al., 2016). Further, the indicator variables under *F4* emphasize the importance of clearly defining the roles and responsibilities of the stakeholders to improve the understanding among the partners. The importance of clarifying the roles of different stakeholders is noted by Liimatainen and Mladenović (2021) highlighting the issues raised by van den Hurk et al. (2021) on concomitant ownership and responsibility. Both MaaS schemes considered in Phase I allocated the stakeholder roles based on their capabilities to inculcate shared responsibility.

Emphasis on societal motives (F5) captured the need for MaaS products to focus on societal objectives. This coincides with Phase I which had a stronger emphasis on societal motives from both the private and public sectors. Considerations of the societal motives of the stakeholders appear in Phase I only as a subconstruct of understanding among the partners. Although the existing literature supports achieving level 4 integration (Ho et al., 2021b; Pangbourne et al., 2020; Smith and Hensher, 2020; Sochor et al., 2018) with the cross-subsidisation from the government, indicator variables included in *F5* had an overlap with this view as they advocate the need for regulatory authorities to subsidise MaaS in return for the societal benefits that it delivers. However, Hensher et al. (2021c) state that the plausibility of granting such subsidisation would be a challenge for governments without having significant evidence of achieving sustainability goals.

5.5.2 Differences between Phase I and Phase II

The differences between the two phases are helpful in gaining a comprehensive understanding rather than negating factors that only appeared in one Phase. The contextual factors did not emerge in Phase II even though the measured variables included in the survey contained context-related variables. It is important to note that the measured variables included under *creating open data standards (F2)* support a more specific factor which represents the involvement of regulatory authorities in developing open data standards in contrast to the structure of the regulatory environment. Active regulatory involvement emerged as a key factor under Phase I to develop suitable legislation including open data standards and to create a vision for MaaS to enable MaaS developments. Developing suitable legislation and open data standards were recognised as two key constructs that enabled trust in the Whim MaaS scheme. The regulatory environment is found to have a strong impact on building trust in MaaS ecosystems. The active involvement of regulatory authorities to enable MaaS developments has been highlighted in numerous scholarly articles (Arias-Molinares and García-Palomares, 2020; Hensher et al., 2020; Meurs et al., 2020; Smith and Hensher, 2020; Smith et al., 2018b; Surakka et al., 2018; Veeneman, 2022). Phase I suggests further involvement of the regulatory authorities, specifically the public transport authority through co-operating with the private TSPs which aligns with the suggestions of Smith et al. (2018a) and Smith et al. (2018b). Chapter 6 elaborates more on the policy implications emerging out of this research.

The *commercial motives* did not directly emerge as a factor under Phase II even though it emerged as an important construct in Phase I under the *understanding among partners.* Wong et al. (2020) highlight the need for an in-depth understanding of the commercial interests of the stakeholders when developing suitable MaaS organisational models to arrive at an equilibrium where MaaS can deliver both societal and commercial motives. Phase I segregated the identified commercial motives under two main themes namely, *gaining market share* and *exploring business opportunities.* The key reason for the emergence of these constructs in Phase I could be the in-depth interviews conducted with stakeholders which allow them to share the implicit expectations unlike in an online survey study which has a predefined set of responses.

The importance of *having a shared vision* for MaaS in the transport landscape is an important construct that was only recognised in Phase I. Lack of shared vision has been

identified as a barrier to MaaS developments by some studies (Meurs et al., 2020; Smith et al., 2018b) even though the study does not suggest a stakeholder responsible for setting up the vision. The findings emphasise the need for higher-level authorities to set the vision for MaaS. Such practice can be seen in jurisdictions where regulatory authorities were shaping MaaS developments. The Whim MaaS scheme in Helsinki is one such example. In the Sydney MaaS trial, *having a common goal* replaced the shared vision given the passive involvement of the regulatory authorities. This led the stakeholders within the ecosystem to formulate a common goal when working towards realising MaaS. These contextual differences could have impeded the emergence of shared vision as a strong factor in Phase II.

Identifying conflicts emerged as a construct that creates mutual understanding in Phase I specifically in the context of the Whim MaaS scheme. This fosters mutual understanding by recognising the limits of arriving at a consensus, acknowledging those limitations and progressing forward. *Identifying conflicts* was not prominent in the Sydney MaaS trial and neither in Phase II. This could be probably due to the contextual differences in the Whim MaaS scheme, where Nordic countries are usually considered to have higher levels of public-private collaboration compared to other contexts (Mladenović and Haavisto, 2021). The *capability of the partners* is another important construct that did not emerge as a separate factor under Phase II. Two of the measured variables under *mutual understanding (F4)* captured conditions related to the recognition of stakeholder capabilities and finding the synergies among the stakeholders. However, the *capability of the partners* in Phase I mainly refers to the ability to execute the assigned role and the relevant expertise. Table 5.7 provides a summary of the comparison and drawing on these discussions the next section integrates the findings of Phase I and Phase II.

Table 5.7: Comparison between the two phases

Area	Phase I	Phase II
Contextual factors	nature of the MaaS scheme, user attitudes, transport network, regulatory environment, ICT infrastructure	
Factors that lead to trust	the capability of the partners, prior relationship, accountability, appropriate contracts, regulatory enforcement, open data standards, flexible contracts	developing open data standards (F2), prior relationships (F7),

		transparent agreements (F8)
Motives for joining	commercial motives, societal motives	
Outcomes of collaboration	continuous innovation, going the extra mile, level playing field, developing together, co-creation, working as a team, findings mean to overcome barriers, coopetition	coopetition (F6)
Other factors for collaboration	identifying stakeholder objectives, identifying synergies, expectations management, having a common goal, having a MaaS champion, understanding of MaaS, identifying conflicts, open MaaS ecosystems and open negotiations, win-win agreements, having a vision	understanding the need for collaboration (F1), need for MaaS champion (F3), mutual understanding (F4), emphasis on societal motives (F5)

5.5.3 Combining the insights from the two Phases

The interrelationship of the factors identified in Phase II can be inferred using the relationships between the constructs that emerged in Phase I as all the factors in Phase II were identified as constructs in Phase I. The ability to gain a holistic understanding is the major strength of complementing the two methods which extend beyond the verification conducted in sections 5.5.1 and 5.5.2.

The conceptual models developed in Phase I had different types of constructs, namely contextual, trust-related, collaboration-related and the outcomes of collaboration. Phase II was developed with the intention of finding validation and comprehensiveness for constructs related to trust and collaboration. The factors that emerged in Phase II were categorised under trust-related (*developing open data standards, prior relationships and transparent agreements)* and collaboration related (*need for MaaS champion, mutual understanding, emphasis on societal motives, coopetition, understanding the need for collaboration)*. Although some factors did not emerge as constructs of both conceptual maps created during Phase I, they were present in at least one of the two conceptual maps.

The constructs that only emerge in Phase I include the *capability of the partners, identifying commercial motives, having a shared vision* and *identifying conflicts*. Some of the measured variables loaded under the eight factors in Phase II captured statements related to the above constructs even though the factor loadings were not strong enough to identify them as separate factors. The differences between the two Phases can be due to several reasons. The results in Phase I were based on two case studies and the contextual factors may have an impact on the factors such as *expectations management, having a vision for MaaS, open data and APIs*. Further, the identification of contextual factors needs a more interpretive understanding of the situational circumstances of the two case studies and hence could mostly be discovered using a qualitative approach such as in Phase I.

The intention of integrating Phase I and Phase II is aimed at developing a comprehensive theoretical framework that encapsulates the factors that would lead toward trust and collaboration in MaaS ecosystems. In summary, trust is identified as an antecedent for collaboration in MaaS ecosystems. The trust can be established by the active involvement of regulatory authorities through developing suitable legislation covering open data standards and fair contracts. This can lead to open ecosystems which will enable the potential stakeholders to develop MaaS solutions by integrating with appropriate stakeholders. *Open and transparent agreements*, the *capability of the partnering organisations* and *prior relationships among the stakeholders* are other factors that are essential in building trusting relationships.

Although the collaboration is induced by trust some other factors are necessary to intertwine with the trust to build collaborative relationships. This starts with recognising both commercial and societal motives of the stakeholder organisations that lead towards mutual understanding among each other. This stimulates the proper expectations management in the event of strategic deviations which could induce conflicting situations. The vision for MaaS becomes important in such cases in arriving at a common consensus and formulating a common goal. Further, mutual understanding assists in identifying win-win negotiations and agreements that would synergise the complementary capabilities of varying stakeholders within the ecosystem. Having a MaaS champion plays a vital role in this entire process of navigating and directing the stakeholders through challenging situations. Such an organisation can facilitate the formation of a common goal that will fall in line with the broader societal goals that MaaS intends to achieve.

5.6 Conclusion

This chapter has described analytical steps and the results of EFA conducted under Phase II of this research. Eight factors emerged as important elements for inducing trust and collaboration in MaaS ecosystems which were described in detail under section 5.2. Subsequently, these factors were compared with the results of Phase I to both verify and gain a comprehensive understanding of the factors and constructs and their interrelationships that would facilitate collaborative relationships. The findings of Phase II confirmed the findings of Phase I. However, as discussed in section 5.5 few constructs appeared as important in Phase I that did not emerge as factors in Phase II mainly due to the distinctiveness of those constructs to the contextual setting.

Although it would not be rational to propose a universally applicable model for trust and collaboration, the understanding of these factors and their interrelationships would assist policymakers in making necessary interventions to give MaaS applications an opportunity to thrive. Further, understanding these factors, constructs and interrelationships would assist the MaaS practitioners when entering into partnerships with other stakeholders. The next chapter provides details about the policy implications that arise out of this research.

CHAPTER 6 IMPLICATIONS FOR POLICY AND MAAS ORGANISATIONAL MODELS

This chapter presents insights into policy and MaaS organizational models building on the findings of this research. Section 6.1 presents the policy implications and suggests changes that need to occur in the legislative and regulatory environment. Subsequently, section 6.2 presents how the constructs and factors identified in Chapter 4 and Chapter 5 facilitate trust and collaboration in various organizational models aimed at delivering MaaS. The chapter concludes with section 6.3, providing some insights for shaping future MaaS developments.

6.1 Policy Implications

This section highlights the policy implications based on the findings of Phase I and II. Extant MaaS literature pinpoints that there is limited guidance for policymakers (Smith and Hensher, 2020) and this section aims to contribute towards filling this gap. Both Phases of this study synchronize the involvement of regulatory authorities in enabling MaaS developments. This discussion offers policy implications and compares with the extant literature to highlight the key areas of policy interventions that emerged out of this research.

6.1.1 Developing suitable policies and regulations

Previous studies have highlighted the importance of developing suitable policies and regulatory frameworks to enable MaaS developments (Arias-Molinares and García-Palomares, 2020; Hensher et al., 2020; MaaS Alliance, 2017b; Meurs et al., 2020; Mulley and Nelson, 2020; Smith and Hensher, 2020; Smith et al., 2018b; Surakka et al., 2018; Veeneman, 2022). Smith and Hensher (2020) have developed a framework consisting of nine areas of innovation (refer to section 2.4) that the public sector policies should address to enable MaaS. The authors have suggested reviewing and revising the framework with empirical evidence and detailing the policy interventions in each area. The policies suggested in this section extend this framework by providing details on how the interventions can be executed in the areas of MaaS related objectives, rules, technologies, alternatives and partnerships.

The results indicated the need for regulatory authorities to play an active role in enabling MaaS developments. The accountable government ministry is required to develop suitable policies in consultation with local authorities and the regulatory agencies at all levels need to act in their capacity to facilitate the policies set at the decision-making level. These policies should align with the broader economic, societal and political objectives of a

particular jurisdiction. The national authorities (such as ministries and agencies) should facilitate this through constructive discussions with regional and local authorities and develop suitable legislation. Although the specific details of the policies depend on contextual factors, some key areas need to be focused upon. Having a vision, open data standards and societal goals emerged as the key policy interventions that need to be executed by the public sector. However, it is important to note that the regulations related to MaaS would most certainly need revisions based on the stage of the development of MaaS (Hensher, 2017; Meurs et al., 2020; Smith and Hensher, 2020).

6.1.1.1 Setting up the vision for MaaS

The vision for MaaS sets a clear direction for the stakeholders within the ecosystem (König et al., 2016). Although involvement type and level could vary (e.g., actively disengaged vs. actively engaged), the government should set up the vision for MaaS in a particular jurisdiction. In Finland, MaaS vision seeks to transform mobility into a single service enabled through digitalisation aimed at decreasing personal vehicle use. Scotland's MaaS vision aims at smarter, faster and greener travel by empowering the MaaS community to offer new and alternative ways of travel to fulfil user needs with the advancements of technology. MaaS vision should be consistent with the future transport strategy of a particular jurisdiction and recognize the contribution that MaaS can make to broader societal, economic and political priorities. One of the main arguments for setting up the vision is to provide assurance and encourage the stakeholders in the ecosystem to commit to a long-term business venture. A clear vision facilitates MaaS schemes to advance from level 3 (booking and payment integration) to levels 3 (service bundling) and 4 (societal goals) of Sochor et al. (2018) terminology (refer to section 2.5.5).

The vision for MaaS should complement the existing and planned urban planning and infrastructure to develop a better solution that will enhance the value creation for the users. The vision for MaaS should be reflected in the official documents published and released by regulatory authorities at all levels to ensure consistency which is essential in building confidence and trust amongst the ecosystem actors. The findings in Chapter 4 indicated that the inconsistencies in the vision have impeded the scaling up of MaaS due to the uncertainty for MaaS in the transport landscape. For example, even though Finland has a vision for MaaS, it is not the same among different regulatory levels. This created some tensions between the public and private sectors resulting in disinclination among the private sector

stakeholders (such as MaaS operators, app developers and TSPs) to commit their resources to an uncertain business venture. This implies the need for local regulatory authorities to align with MaaS vision when planning transport infrastructure and initiating transport-related innovations.

Even though the vision for MaaS should depend on the priorities of each jurisdiction, it is preferable to be mode agnostic (Hensher et al., 2020) and attuned towards a sustainable transport future. Consequently, the stakeholders who perceive that they could align their strategic objectives with MaaS will join the ecosystem. Most of the stakeholders will acknowledge the difficulty in completely bridging the differences between the motives of public and private actors and even within the private sector actors. In conformance with Mladenović and Haavisto (2021) and Mulley and Nelson (2020), the findings of this research indicate embracing such differences would lead to effective partnership formation and establishing a common goal. One key policy instrument that a particular government may use in implementing this vision is through developing appropriate legislation and regulations aligned with the overarching vision.

6.1.1.2 Open data standards

Open data standards refer to the specific set of guidelines developed to facilitate sharing, exchanging and use of data in an interoperable manner. These define common formats, standards, structures, and procedures that enable different systems and applications to exchange data effortlessly. Government intervention is necessary for developing these open data standards (Meurs et al., 2020; Smith and Hensher, 2020; Surakka et al., 2018) as it possesses the authority and capacity to develop and enforce such standards. These open data standards become crucial for MaaS to achieve higher levels of booking and payment integration (Ho et al., 2021b; Sochor et al., 2018). Findings of both Phase I and Phase II emphasize the stakeholder opinion for the government to be involved in developing suitable standards covering the design and development of compatible OpenAPIs.

OpenAPI is the key open data standard that ensures Application Programming Interfaces (APIs) are designed and documented using a structured approach that enables different systems and applications to communicate using a common platform. As described in section 4.2.3.3 open data becomes important for the initiation and operation of MaaS as it is a service designed by integrating the services of different stakeholders who have their own information systems and platforms. If these platforms and the APIs are not compatible,

MaaS integrators would face difficulties in synchronizing different platforms together due to inconsistencies among platforms. This creates significant costs in both the design and operational stages and hinders the innovation capabilities within the ecosystem. Further, open and standardized APIs form the basis for ticketing integration improving interoperability. OpenAPI standards ensure different stakeholders can access, reuse and share data to promote innovation, collaboration and transparency. Lack of compatibility is highlighted as one of the key challenges that stakeholders in both the Whim MaaS scheme and Sydney MaaS trial faced at the point of initiation. In the case of the Whim MaaS scheme, this was resolved with time due to the legislative enforcement of open data standards. Even though the legislation enforced the open data standards the private and public sector has the implicit duty to develop compatible and user-friendly APIs.

6.1.1.3 Ensuring the delivery of societal goals

The importance of societal motives emerged as a factor that has an indirect influence on creating a collaborative environment. This emerged as a subconstruct in Phase I and a key factor in Phase II. The overarching promise and motivation of MaaS are to create sustainable travel patterns (Hensher et al., 2020; Sochor et al., 2018; Veeneman, 2022). Almost all the MaaS schemes or trials came to exist with this underlying objective or promise rather than arising out of identifying only a user need. Some argue that meeting user demand and having a value proposition for customers need to be key criteria for transport innovation; however, it is important to note that the most popular user choice may not always be the best choice for society.

Findings of Phase I and II both indicated the need for the government to subsidise MaaS schemes to ensure the delivery of societal goals. In Phase II, this need was identified under the factor *emphasis on societal goals (F5).* The need for subsidisation strongly loaded on *F5* under two indicator variables with loadings of 0.75 and 0.69 loadings. In Phase I subsidisation does not emerge as a key construct as there were conflicting opinions on this among different stakeholder groups. While the MaaS operator and other private actors advocated the need for at least cross-subsidising MaaS in return for societal benefits, the public actors required it to be a standalone product. One key argument was the heavy subsidies which are already in place for public transport. The market-driven economy encourages the survival of products that can be standalone without any external funding as these are motivated by commercial goals.

The findings of Phase II indicate that MaaS struggles to sustain itself financially as a standalone product without the support of external funding in the initial stages. This problem may largely be solved once MaaS scales up, in both spatial coverage, multi-modality and market share, generating the benefits of the economies of scale. Many governments currently subsidise public transport, sometimes heavily, in return for the societal benefits that it delivers such as reduced traffic congestion, lower carbon emissions and less consumption of resources. These are the same goals that MaaS attempts to achieve but with an innovative framework that leverages digital advancements to integrate multiple services and offer an alternative to a private car. It is the responsibility of the beneficiaries to facilitate systems such as MaaS at the initial stages for a sustainable future. This helps MaaS products to achieve level 4 integration (societal) of Sochor et al. (2018) terminology by offering a solution that delivers societal objectives.

Numerous scholars have indicated the need to subsidise MaaS schemes (Hensher et al., 2020; Ho et al., 2021b; Meurs et al., 2020; Sochor et al., 2018). Veeneman (2022) suggests these subsidies can also be in the form of incentives that will motivate the existing operators to open pricing schemes. Mulley and Nelson (2020) discuss supply and demand side subsidies in detail suggesting incentive payment per passenger (IPP) as a suitable way of subsidising MaaS. The public transport subsidy can be built into IPP in the form of an incentive based on the usage of public transport by the passenger. This needs operators with an understanding of the underlying dynamics of bundle options and choices (Ho et al., 2021a; Ho et al., 2021b) which promotes sustainable travel behaviour. Ho (2022) has quantified the amount of Pigouvian subsidy that needs to be offered to different MaaS bundles in terms of the reduction of CO2 emissions based on the findings of the Sydney MaaS trial which is instrumental for subsidy-related policy interventions for MaaS. The means of integrating these societal goals into MaaS schemes using societal KPIs are discussed in detail by Hensher et al. (2023).

In summary, all the regulations discussed above benefit the MaaS operators in developing MaaS products in an open MaaS ecosystem. This refers to the creation of a level playing field that ensures that any stakeholder with the necessary competencies can develop a MaaS solution integrating with any of the stakeholders in the ecosystem, be it private or public. The higher levels of booking and payment integration need both open data standards and enforcing regulations to ensure the interoperability of ticketing systems and infrastructure. A shared vision helps to design and develop both user and environment-friendly bundles

and packages as stakeholders with a common vision would work towards improving the MaaS solutions continuously. The societal objectives and subsidies would ensure the MaaS objectives will be better aligned with the societal goals.

6.1.2 The role of the government

The above discussions indicate that governments should actively enable MaaS developments. Veeneman (2022) highlights the possible downsides of purely market-driven decisions by the MaaS operators such as increased car use induced by unsustainable but profitable (for the operator) bundle designs. It is value-adding to discuss the role and level of involvement that the public sector has in MaaS developments. Unarguably, the role of the government depends on many factors including the MaaS organisational models and other contextual factors. Based on the findings of this research this section discusses the suitable level of government involvement that is necessary to enable MaaS.

The importance of adopting a collaborative innovation approach in the public sector to manage disruptive innovations like MaaS is repeatedly emphasized by researchers (Smith and Hensher, 2020; Smith et al., 2018b). This assists in challenging bureaucratic practices, breaking organizational silos and shattering policy deadlocks. It is necessary for the government to induce a collaborative space and work with private sector actors when implementing MaaS. Mladenović and Haavisto (2021) have discussed prospective ways of government involvement and advocated an *'activist laissez-faire'* approach for facilitating the MaaS developments. Findings of Phase I suggest that the national level authorities such as ministries, have the key role of developing suitable legislation and policy frameworks and establishing a shared vision for future transport developments. The local authorities need to be informed about these regulations and policy frameworks which may assist in aligning the infrastructure and planning strategies to complement the MaaS developments.

In the case of Finland, the government adopted mainly a hands-off approach despite few hands-on interventions such as discussion forums held with the stakeholders in the transport landscape during the initiation stages of MaaS. However, the government was able to develop a progressive policy framework to enable an open MaaS ecosystem. In the case of Sydney, the trial emerged out of the interest of several private sector stakeholders. The public sector had essentially a passive involvement other than providing access to the public transport ticketing systems. In theory, both MaaS models operated under a commercial integrator and hence fall under the *Walled Gardens model* proposed by(WBCSD and ITF,

2020). The stakeholders in both ecosystems perceive that the government should be a stakeholder and actively participate in the ecosystem due to its power, influence, authority, and resources. These attributes enable the government to initiate changes in customer behaviour within the transport landscape (Veeneman, 2022).

In most cases, the governments have perceived their role in developing policy and legislation that would induce MaaS developments. In other cases, governments have been actively involved in the MaaS landscape, taking the MaaS operator role. The findings of this study suggest that the government should take an intermediary position between these two approaches. After the development of suitable policies and frameworks, the government needs to ensure their enforcement as well which may happen in the form of local authorities and PTAs in supporting MaaS. In Finland, one of the key reasons for the rollout of the new transport legislation is the function played by Traficom in enforcing the regulations. There have been instances where local authorities had disputes with the private sector and in such cases having a mediation institution such as Traficom has been instrumental in resolving such disputes.

The local authorities need to be actively involved in aligning their urban and infrastructure plans with the MaaS policy framework and vision. Although the decision for the PTA to be the MaaS operator depends on the context, collaboration with the private sector is crucial to realise and scale up the MaaS solutions. The local authorities can regulate the MaaS developments under their jurisdiction (this could be the national level based on the MaaS scheme) and the PTA can be an active stakeholder who is engaged in the process of developing the MaaS schemes with potential MaaS operators. This will assist in clearing out the fear and suspicion of losing control over the MaaS trajectory (Karlsson et al., 2020) and ensure the achievement of the wide societal goals of public transport.

As discussed in section 6.1.1.3 regulatory involvement becomes necessary to ensure the achievement of societal goals as it is practically hard to encourage private actors to focus on these goals while they are in a continuous struggle to achieve financial sustainability. This creates a case for the *Open and Regulated MaaS model*. The model emphasises the involvement of regulatory authorities in governing and regulating the MaaS platform. Although the government needs to govern the MaaS ecosystem through regulation, it does not need to control and operate the MaaS platform. Doing so would hamper innovation because the private sector has many players with better resources and capabilities to design,

develop, operate and maintain such a platform. Alternatively, the societal goals can be included as a contractual requirement in the MaaS contract as suggested by Hensher et al. (2023) in their utopian MaaS paper. Such a mechanism stands out as an effective mechanism where the government can exert their control while leaving space for the private sector to innovate MaaS service delivery.

In summary, although the respective policies may depend on the context, it is important to understand the fundamental areas in which the government should be involved in shaping MaaS developments such as setting up the vision, developing open data standards and delivering the societal goals. As noted by Smith and Hensher (2020) and Meurs et al. (2020) the policies may need to change as MaaS progresses through its development, diffusion, and maturity phases. Careful attention needs to be given when revising the policies related to the MaaS to minimise the impact on the progression of the MaaS scheme. For example, if a possible revision of the subsidisation policy needs to be introduced, this should not impede the attractiveness of the solution. As evidenced by this research, the development of such policies needs to consider the nature of the regulatory environment, existing transport network, ICT infrastructure, and user behaviour. The role of the government is to develop a suitable policy framework and regulations and to ensure policy compliance. Further, the local authorities and PTA should be actively involved and participate in the MaaS design and development process although it is not essential for them to operate or control MaaS. However, the level of involvement may vary depending on the organisational model of a MaaS scheme.

6.2 Trust and collaboration in MaaS organisational models

The organisational model that MaaS should follow has been a prominent area of discussion over the past decade. Various models have been proposed by both academia and industry and section 2.3 includes a detailed discussion of the structure and nature of the different MaaS organisational models and the resulting ecosystems. This section discusses the insights obtained from this research and the implications they have for the designers, developers and operators of MaaS organizational models. This is not an attempt to specify the effect of these factors on the existing organizational models but rather a constructive discussion on which factors and constructs identified in this research could become important in different MaaS organizational models. Section 2.3 explains how the existing MaaS models can be categorised under two overarching groups namely, government-centred MaaS models and the market-driven MaaS models. This discussion is mainly

focused on the MaaS models proposed by WBCSD and ITF (2020) as most of the existing MaaS models fall within these categories. Figure 2.2 includes an illustration of these models. A detailed discussion of the organisational models proposed by WBCSD and ITF is included in Mulley and Nelson (2020). In the discussion that follows some references are made to existing and proposed organisational models based on their relevance to this discussion.

Walled Gardens is a completely market-led model, and the stakeholders would be mostly driven by commercial motives. The *capability of the partners* including their expertise in performing the expected role becomes important in the process of partner selection. Contracts can still be *flexible and open* but there is also a possibility of having rigid performance contracts given the competition in the market. The Whim MaaS scheme is a perfect example of a *Walled Garden* model apart from the enabling role played by the regulatory authorities in the Finnish context shaping the open MaaS ecosystem. Zipster developed by mobilityX in Singapore is another example although it halted operations around June 2021 and the shareholders pointed out the lack of regulatory support (Abdullah, 2021) as a key issue behind this decision. The constructs such as *prior relationships* and *mutual understanding* might not play a prominent role in this type of ecosystem as long as the *commercial motives* are satisfied and the viability of MaaS as a standalone product is ensured. Until now no evidence shows the potential of MaaS to become commercially viable without the intervention of a third-party funding organisation or government subsidies (Hensher et al., 2021b; Hietanen, 2023). Further, it is not reasonable to have high expectations for the delivery of societal objectives through this model unless there is a considerable push by the consumers for such an initiative. The roles such as *MaaS champion* will only exist if there are adequate margins to share with such additional stakeholders. Hence, the MaaS operator might play both the role of MaaS champion and MaaS operator in such scenarios. Alternatively, if the government chooses to assume the role of the MaaS champion, there would be a strong potential for influencing MaaS advancements to align with societal objectives. In that case, the government needs to have a proper understanding of MaaS and may need to streamline the bureaucratic procedures to facilitate innovation.

Mesh-y MaaS can be categorised as a type of market-driven model as it completely relies on supply and demand matching processes optimised through the use of advances in technology. The blockchain-based MaaS (Chinaei et al., 2022) is an example of such a

model that eliminates the need for a MaaS operator and other intermediaries. Although this model is largely conceptual at this stage, the prospects are high with the rapid developments in technology. The ability of the model to function even with the absence of trust is one of the key advantages claimed by the proponents of this model. However, as discussed in section 5.5.1, even the blockchain-based MaaS models need *open data practices* to realise the crypto tickets which are the building blocks of such a MaaS ecosystem. This implies the need for trust as open data standards can only be effective with trusting partnerships among the stakeholders given the requirement of compatible and user-friendly APIs to integrate with other stakeholders. The role of the government and the regulatory authorities will be minimal in such ecosystems and the consideration given to stakeholder motives cannot be guaranteed. This might lead to concerns regarding the comprehensiveness of the MaaS model and its alignment with societal objectives.

Public MaaS is attuned to a government-centric MaaS model where the PTA or public transport operator governs and runs the MaaS model typically as the sole operator. The public integrator mustn't be currently in competition with the existing private-public operators to ensure impartiality and avoid conflict of interest. *Prior relationships* and the *capability of the partners* may become important in the trust creation process and the contracts need to be *flexible and open* to encourage the TSPs to join the ecosystem although this can largely depend on the authority who runs the MaaS solution given the influence they have over shaping the ecosystem. *Mutual understanding* is another important aspect due to the varying stakeholder motives. The *vision for MaaS* can be helpful in this ecosystem to ensure sustainability and long-term growth. Some key benefits are the ability to align MaaS with broader societal goals and the potential to reach the existing user base to which PTAs already have access. Sustainable travel choices can be promoted through the design of the bundles and incentivising such bundles coupling with the subsidies that already exist for public transport.

Regulated utility MaaS is a hybrid model where the government provides and regulates a platform in which the MaaS operators/integrators provide their MaaS solutions. This indicates the need for *open data standards* if the integrators are to develop solutions by combining the services of different TSPs. Similar to *Public MaaS* the government may have a degree of control over the societal goals through interventions although the platform will operate following a market-driven approach. The Collaboration as a Service (CaaS) proposed by Merkert et al. (2020) is worth mentioning due to the emphasis that it places on

the need for operator-based collaboration to realise MaaS. *Having a common goal* becomes important in such an environment which can be arrived at with mutual understanding and expectations management procedures. The stakeholders will expect *transparency* and *accountability* from the regulators about the strategic directions of MaaS that have an impact on the ecosystem dynamics.

In addition to these models, PPP model proposed by Eckhardt and Aapaoja (2016) under the MAASiFiE project . includes a central MaaS operator company which is formed as a partnership between the private and public actors within the ecosystem. The proponents of this model recommend it mainly for rural and sparsely populated areas. This model needs high levels of trust and collaboration as the entire ecosystem relies on partnerships between stakeholders. However, unlike in other models, most of the *stakeholder expectations* can be included in the partnership agreement itself considering the *differing stakeholder motives*. The *role of a MaaS champion* can help create an understanding of MaaS on the path to establishing a common goal. Further, *capability, prior relationships,* and *appropriate contracts* would play a key role in this type of MaaS ecosystem.

This discussion shows that trust and collaboration play an important role in every MaaS organisational model even though the level of trust, underlying factors that create trust and collaboration and their interactions may differ across the organisational models and the situational context. The organisational models such as *Walled Gardens, Regulated Utility* and *CaaS* may require higher levels of trust given the structure and the composition of stakeholders. The *capability of the partners, prior relationships* and the *nature of the contracts* are important in establishing trust despite the organisational model. The *understanding among the partners, identifying stakeholder motives* and *finding win-win solutions* are some important constructs that will facilitate building a conducive environment to facilitate collaborative innovation in MaaS organisational models.

6.3 The Way Forward

Even though there exist a number of different MaaS organisational models, all of these are still struggling to build standalone and scaled-up MaaS schemes. As outlined in Chapter 2, this research identified a lack of trust and collaboration among stakeholders as a key reason behind this underlying struggle. The constructs and factors that emerged in Phase I and Phase II of this study suggest that regulatory authorities need to play an enabling role in shaping the MaaS developments. On the other hand, private sector, actors need to

understand the value of coopetition when entering into agreements and need to understand the motives of different stakeholders within the ecosystem. This integrated planning approach will facilitate the smooth progression of MaaS development by providing a clear direction to the ecosystem actors and improving confidence.

The role of government should extend beyond designing and developing MaaS-related policies to actively involved in supporting and facilitating MaaS developments. Regulatory authorities should form these policies with an understanding of the factors that facilitate trust and collaboration in different organisational models. Furthermore, the government should promote the alignment of MaaS with societal goals by developing appropriate subsidy and reward schemes for both end users and operators during the initial stages, until MaaS schemes become established in a particular jurisdiction. Drawing on these findings, Chapter 6 has discussed the policy implications emerging through the findings of the study. The next chapter draws together the overall conclusions arising from this research.

CHAPTER 7 CONCLUSION

This chapter includes a summary of key findings in Section 7.1, along with their implications for the industry and contribution to existing literature in Section 7.2. Section 7.3 discusses study limitations, while Section 7.4 offers suggestions for future research directions. Finally, Section 7.5 concludes the chapter by reflecting on the future of MaaS.

7.1 Summary of the Key Findings

Even after a decade of introduction, MaaS is still at the stage of development mainly due to the uncertainties pertaining to sustainable business models and the issues related to scalability (Hensher et al., 2021c; Hietanen, 2023). The review of the literature (Chapter 2) indicates that collaborations, founded on trustful relationships amongst stakeholders, are essential for the development and implementation of MaaS schemes. Smith (2020) researched the importance of private and public collaboration in MaaS highlighting the challenges and potential opportunities. Mulley and Nelson (2020) state that the stakeholders in MaaS tend to underestimate the challenges in the face of achieving trust and collaboration within the ecosystem based on the discussions the authors had with numerous MaaS practitioners. However, detailed investigations on the factors that lead to trust and collaboration in MaaS ecosystems at a holistic level based on empirical evidence was spotted as a key gap in the extant literature. In order to fill this void, this study was designed to investigate about the factors which build trust and collaboration with the MaaS ecosystems and how these factors interact with each other in a given content. Accordingly, two research questions were formulated as described in section 1.3 namely,

RQ1. What factors would facilitate building trust and collaboration within MaaS ecosystems??

RQ2. How would these factors build trust and collaboration among the stakeholders?

The nature of the research questions stipulated a comprehensive understanding of the decisions and actions of the stakeholders within the ecosystem and the underlying reasons behind such behaviours. To gain a holistic understanding of the phenomenon, it was essential to recognise the context in which those decisions and actions took place. This required an interpretive understanding of the phenomena which can be best acquired using qualitative methods. However, the qualitative methods have a limited capability in inferencing and validating the findings over a wider population compared to the

quantitative techniques. Hence, this study was conducted using a mixed-method approach which consisted of a qualitative phase (Phase I) and a quantitative phase (Phase II). Phase II was mainly designed to extend and validate the findings of Phase I using a wider audience. Phase I aimed at answering RQ1 and RQ2 while Phase II was targeted towards verifying the findings for RQ1 that emerged in Phase I. Key findings from both phases are summarised in the subsequent paragraphs.

Phase I initially investigated the constructs that lead to trust and collaboration (RQ1) and subsequently developed two conceptual models that illustrate the formation of trust and collaboration (RQ2) in MaaS ecosystems using a Constructivist Grounded Theory method (CGTM). These empirically developed conceptual models which encapsulate the constructs and their interrelationships in forming trust and collaboration represent the main theoretical contribution of this thesis. As discussed in Chapter 3, the study design followed a case study-based approach employing semi-structured in-depth interviews conducted with the stakeholder organisations in the *Sydney MaaS trial (SMT)* in Australia and the *Whim MaaS scheme (WMS)* in Finland. The data analysis was conducted using CGT coding techniques. The conceptual models presented in Chapter 4 consisted of constructs that represent the elements that influence the formation of trust and collaborations and their interrelationships. The contextual factors such as *regulatory environment, user preferences, transport network, ICT infrastructure and the nature of the MaaS scheme* were found to have a direct influence over the constructs that shape trust and collaboration within the MaaS ecosystem.

Appropriate legislation that *facilitates open data standards, capability of the partners, prior relationships, open negotiations* that lead to *win-win solutions* and *contract terms* that create both *accountability* and *flexibility* in the face of the varying circumstances emerged as the key constructs that form trust in a MaaS ecosystem. It was evident that trust acts as the antecedent and catalyst for building collaborative space within a MaaS ecosystem. The *identification of stakeholder motives (commercial and societal), mutual understanding, expectations management, having a shared vision or a common goal, identifying conflicts, having a MaaS champion* and *understanding about MaaS* emerged as constructs that are essential for collaboration apart from trust.

Chapter 4 explains how these constructs are related to each other and interact with each other in creating a conducive environment for stakeholder collaboration and how the

existence and interrelationships varied between the two case studies namely, *WMS* and *SMT*. The involvement of the government in enabling MaaS developments through introducing open data standards and fair contracts is one of the key differences between *SMT* and *WMS*. Moreover, findings of Phase I indicated that collaboration among the stakeholders created an environment which facilitates teamwork to co-create with each other, going beyond their role-based silos instead of restricting to contractual agreements. This enabled the continuous innovation that is essential for emerging technology-driven services such as MaaS which is still at the stage of development.

In Phase II, these specific results were validated using a survey questionnaire that was distributed among the stakeholders involved in MaaS developments across the world. Section 5.4 contains a discussion about the factors that were extracted using EFA followed by section 5.5 which explains how the findings of Phase II overlapped with the findings of Phase I. Accordingly, some of the constructs identified in Phase I did not emerge as factors in Phase II. Some of the factors in Phase II captured one or two statements indicating the importance of such non-emerged constructs although the factor loadings were not strong enough to recognise them as separate factors. These include *understanding MaaS, identifying conflicts, the capability of the partners, having a vision or common goal* and the *need to achieve commercial motives*. These differences were used in gaining a comprehensive understanding rather than an exercise limited to validation. One of the key reasons for these differences would be the differences in the context and the significance given to the opinion of the majority in the quantitative techniques. This limitation can be addressed by combining quantitative methods with qualitative methods which possesses the ability to acknowledge the views of minority based on the researcher's expertise, provided their relevance to the domain of interest is confirmed.

Findings of both phases indicate the need for the *involvement of regulatory authorities* in developing necessary policy frameworks. The policy implications include suggestions for designing suitable legislation followed by the regulations to enable MaaS developments. *Setting up a vision for MaaS, having open data standards, developing suitable subsidies to align with societal goals* and *ensuring stakeholder compliance* to the established regulations appeared as fundamental areas in which the government can influence, irrespective of the context. Chapter 6 further illustrates how the government can intervene and enable these developments within the transport landscape. Although most of these policies are hands-off the government and other regulatory authorities can be involved in

hands-on interventions depending on the context. The active involvement of the PTA has a significant influence on scaling up the MaaS solutions, but that does not necessarily mean that the PTA should become the MaaS operator. The necessity is to collaborate with the private sector actors in developing a comprehensive MaaS scheme which would eventually assist in delivering societal goals in the long term (see section 6.1.1.3). Nevertheless, it is important to note that the nature of the stakeholders and their interrelationships in a MaaS ecosystem depends on the organisational model under which it operates.

There are constant debates about the most appropriate organisational model, but it is safe to state that this depends on contextual factors such as the regulatory environment, development of ICT infrastructure and the transport network of a given jurisdiction. An organisational model that can deliver the aims of MaaS while meeting the partner's intentions appears to be necessary for trust and collaboration. As discussed in section 6.2, the emergence and the interplay of the factors identified in this research vary given the structure of the organisation model of MaaS. Some organisational models may require higher levels of trust whereas others may function well with a minimum level of trust. The level of trust required, and the level of regulatory involvement depends on the position of the MaaS scheme in the market-driven and government-led continuum. Although this position can be controlled by the government through the regulations it is recommended to have participatory discussions with the stakeholders in the transport landscape before developing such policies and regulations.

7.2 Contribution

This thesis provides a detailed understanding of building trust and collaboration in MaaS, verifying the factors that lead to improved trust and collaboration among the stakeholders. This study elaborates on how these factors interrelate with each other by proposing a conceptual model as its key theoretical contribution, comparing, and contrasting two case studies conducted in different regions with varying outcomes. Further, this study informs, through an in-depth analysis of the two selected case studies, how these identified factors lead to building trust and collaboration in MaaS. Subsequently, the findings have been validated using EFA conducted on the data collected through an international survey aimed at MaaS practitioners worldwide. The mixed method approach allowed a holistic understanding of the phenomenon which can be suggested as suitable for future studies focusing on similar aspects of MaaS.

In terms of practical contributions, industry practitioners could use these insights generated based on real-world scenarios to understand how to induce trust and collaboration in MaaS ecosystems. Chapter 6 provides a detailed discussion of how the regulatory authorities should enable MaaS developments and the importance of having adequate participation in the process of developing the MaaS scheme to ensure alignment with broader societal goals. It emphasises the need for regulatory authorities to develop contemporary policies and procedures by being informed of the factors that cause collaboration to thrive within a MaaS ecosystem. Chapter 6 further outlines how the level of trust, and the underlying factors and interrelationships that influence this, vary based on the MaaS organisational model. Although adopting a particular MaaS organisational model depends on the context, gaining an understanding of key factors and interrelationships would assist in planning, developing and implementing MaaS schemes. The factors that emerged in this study are mostly applicable to organisational models without the active participation of the government and regulatory authorities (*Walled Gardens*) even though WMS has a strong influence from the policy and legislation that facilitated MaaS developments. Although this research has postulated the importance of these factors for the other organisational models *(Regulated utility MaaS, Public MaaS, Mesh-y MaaS*) those need to be supported with empirical evidence. Moreover, awareness of these dynamics related to trust and collaboration could assist in developing more comprehensive readiness indexes (see section 2.5.5) for MaaS including the preconditions that are necessary for building a conducive environment for MaaS developments.

7.3 Limitations

It is important to acknowledge limitations, most of which are intrinsic to the qualitative techniques. First and foremost, generalisability is one key limitation, given the limited number of case studies selected and investigated due to the consideration given to the feasibility of accessing in-depth information and the presence of a suitable case. The case study selection was restricted by the potential of accessibility to key stakeholders and willingness to share the information due to the sensitivity of the data collected. This was largely mitigated by employing a quantitative survey aimed at a wider audience during the Phase II of the study.

Furthermore, these findings might have been influenced by the researchers' opinions and beliefs despite the precautionary actions taken in the process of data collection and analysis. The follow-up questions of the in-depth interviews were focused on emerging themes, and

hence, there could be some areas that might have been omitted when pursuing the emerging themes. The researcher was more familiar with the Sydney MaaS trial than Whim in Helsinki, although there was no direct involvement with the project. This might have resulted in some preconceived constructs and themes in Phase I.

The COVID-19 pandemic has had a significant effect on both case studies under investigation and this limited the possibilities of observing and interacting with stakeholders using an infield study which would have been immensely beneficial for a qualitative study, especially in terms of interpreting the research findings. The disruptions created by the COVID-19 pandemic resulted in tight working schedules for employees in the transport landscape resulting in extended time frames when scheduling the interviews. Further, the protocol for ethics approval restricted the effective time available for conducting the data collection for each phase. Although the researchers designed the quantitative study after the preliminary analysis of Phase I, an extended time would arguably have provided the chance to develop a more refined questionnaire for Phase II. Nevertheless, it is important to gain more understanding of how the formations of trust and collaboration differ based on the contextual settings. Hence, it is suggested to conduct comparable case studies centred on MaaS operations to investigate the formation of trust and collaboration in various contextual settings.

The sample size of Phase II is another limitation of this study. The survey questionnaire consisted of 71 measured variables and the survey was taken by only 100 participants, out of which 84 participants provided useful data for the analysis. Although the targeted participants represent a niche group, the relatively small sample size raises concerns about sample adequacy for factor analysis. This was partially addressed by selecting a suitable common factor model namely, Regulatory Exploratory Factor Analysis which caters to complexities that arise from the small sample sizes in the EFA process. Another issue associated with the survey is the limited emphasis on cultural and institutional aspects. Although some of these aspects are included in the survey, such as country of operation, organisation type (private vs. public), and employment type (refer to section 5.3), more specific factors such as policy regimes, technological development, and cultural norms were not evaluated. Hence, careful consideration must be given to these factors when applying the findings of Phase II to a specific context.

7.4 Future Research Directions

There remains considerable interest around the world for MaaS as observed from different trials and MaaS schemes which adopt various organisational models and value propositions. This would influence the structure of the factors and their interrelationships to a greater extent in future work. As discussed in section 7.2, it would be worthwhile to study how the constructs and interrelationships may change across the organisational models. It is useful to investigate the level of trust required by the different organisational models, the constructs and factors that would be crucial for the models that are existing and emerging in the MaaS landscape.

Moreover, it would be interesting to understand the effect and the impact of each of the constructs and factors identified in this research study in terms of the level of significance. Although this research investigated the factors that relate to trust and collaboration it does not evaluate the significance of the factors that emerged. A qualitative approach would be most suited for such an inquiry due to the nature of the factors and the quantitative methods can assist in complementing the findings to drive the level of significance. This can be extended considering the role played by uncertainty and time in the development of trust and collaboration within the ecosystems. This needs considerable access to in-depth information which the participants would likely be reluctant to share and hence the researcher needs to carefully design the research and interview to obtain the subtle information.

Further research can also be conducted on validating and measuring the nature of interrelationships between these factors and on the ways of enabling an environment that facilitates the existence of these factors. Although areas such as contextual differences and measurement issues were predominantly captured through the qualitative phase, there is a suggestion that the outcome of the quantitative phase might be further complemented by a qualitative inquiry to enhance the validity of the results. It is recommended to undertake studies using a longitudinal approach to observe changes in trust over a given time period. However, as mentioned earlier it should be noted that determining the subtle complexities included in concepts such as trust and collaboration using a quantitative methodology would be an arduous task. The findings of the research provide a firm commencing point for such research as the initial exploratory work is already designed and developed. Application of structural equation modelling would assist in such a case due to the complexity involved in determining independent, dependent, moderating and mediating

factors. This will enable the creation of different hypotheses related to the interactions among different variables. This type of study would need access to different MaaS schemes which would consume considerable time and resources.

In addition to the above specific areas, it would be worthwhile to investigate the potential for developing scalable and standalone MaaS products. Without a viable business case for MaaS, the likelihood of forming collaborative partnerships would be minimal, given the involvement of both public and private actors. The current trend towards developing MaaS solutions targeted at niche markets, such as tourists, university students, employees, and elderly care, can complement the scalability of MaaS. Another avenue worth exploring is the potential of integrating non-mobility services, enhancing the attractiveness of the solution and creating indirect investments and revenues for MaaS solutions.

7.5 Final Words

MaaS suits well with emerging market solutions which are aligned towards servitisation, shared economy and sustainability. Providing a more user-friendly and sustainable transport solution is the promise of MaaS. Similar to other contemporary solutions MaaS is empowered by advancements of technology. However, MaaS has been struggling for a decade mainly due to issues pertaining to scalability and profitability. Different MaaS organisational models have been proposed by both industry and academia for the delivery of a particular MaaS solution but most of them have been unable to stand successfully against the test of time. A typical MaaS ecosystem consists of MaaS operators, transport service providers, regulatory authorities, research institutions, app developers and ICT infrastructure providers. MaaS is realised as an outcome of synergising the capabilities among these stakeholders. This requires trust and collaboration among the partners given the uncertainty in MaaS developments which necessitates continuous innovation.

Although the recent emphasis is focused on proposing suitable organisational models, equal emphasis needs to be given towards building trust and collaboration between the stakeholders within a MaaS ecosystem as it affects any organisational model. It was evident that it is difficult to propose a universally accepted model for trust and collaboration in the MaaS ecosystem given the impact of the contextual factors. However, understanding the influence of factors such as suitable regulations, the capability of the partners, transparency, the nature of the contracts and prior relationships would be beneficial in building trustworthy relationships. Further, this study suggests identifying the motives of

stakeholders, identifying synergies and conflicts, mutual understanding, having a vision or common goal and having a MaaS champion can extend the trusting relationships towards a collaborative environment. It is important to acknowledge that the involvement of regulatory authorities is essential to enable MaaS developments. Regulatory authorities need to develop suitable policies under an overarching vision focusing on open data standards and the achievement of societal goals. Most of these factors would be influential regardless of the context and the organisational model of a particular MaaS scheme. Proper understanding and acknowledgement of these factors and their interrelationships would assist stakeholders, practitioners and researchers in navigating the MaaS schemes through (inevitable) challenging phases.

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APPENDIX A

Sample semi-structured questionnaire - Phase I

THE UNIVERSITY OF SYDNEY

Institute of Transport and Logistics
School of Business

ABN 15 211 513 464

Sample semi-structured questions

How can we build Trust and Collaboration among Mobility as a Service stakeholders?

General

- Briefly explain about your organisation and the role that your organisation played / plays in the MaaS scheme?
- How did you join?

Expectations and achievements

- What were the motives behind joining?
- Were you able to achieve those through this scheme?
- How do you see the financial benefit achieved from MaaS?

Nature of relationships

- What do you think about the nature of the contracts between the stakeholders? Are they restrictive or flexible?
- How long did it take to familiarise with each other?
- Are the stakeholders using a common information management system? Is data visible to all stakeholders?
- Were you given the opportunity to suggest any improvements to the scheme as a stakeholder? Are there any examples of how you did that?
- Who, in your opinion was the most instrumental stakeholder in terms of service delivery?
- How frequently do the stakeholders meet with each other to discuss the way forward?
- Are you aware of the organisational model under which you operate?

Future Intentions

- What factors do you think would facilitate the (ongoing/future) collaboration and interaction between the stakeholders?
- What are the long-term goals of your organisation pertaining to MaaS?

APPENDIX B

Survey Questionnaire - Phase II

Building Trust and Collaboration among the stakeholders in a MaaS ecosystem

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Start of Block: Block 2

Q26 How can we build trust and collaboration among the stakeholders in a Mobility as a Service ecosystem?

The purpose of this survey is to identify the factors that contribute to trust and collaboration in a Mobility as a Service (MaaS) ecosystem. You have been invited to participate in this study given your interest in MaaS developments. Participation in this research study is voluntary.

Thiranjaya Kandanaarachchi is conducting this study as the basis for the degree of Doctor of Philosophy undertaken at The University of Sydney Institute of Transport and Logistics Studies (ITLS). This will take place under the supervision of Professor John D. Nelson and Dr. Chinh Ho. If you would like to know more at any stage during the study, please feel free to contact Thiranjaya Kandanaarachchi (Thiranjaya.kandanaarachchi@sydney.edu.au).

The survey will take approximately 15 minutes to complete. It is recommended to take the survey using a desktop or a tablet.

For more information about the survey, you are encouraged to download the Participant Information Statement.

I have read the Participant Information Statement, and clearly understand what will be involved in this survey, the risks and benefits of participation, how the data will be protected and used, and the voluntary nature of taking part. I wish to participate in this anonymous survey and give my consent below.

- ○ Yes, I give my consent (1)
- ○ No, I do not give my consent (2)

Skip To: End of Survey If How can we build trust and collaboration among the stakeholders in a Mobility as a Service ecosys... = No, I do not give my consent

End of Block: Block 2

Start of Block: Default Question Block

Q1 Which of the following best describes your organization?

- ☐ Transport Service Provider (TSP) (1)
- ☐ Public Transport Authority (2)
- ☐ Ministry (3)
- ☐ Local Authority (4)
- ☐ App Developer (5)
- ☐ University (6)
- ☐ Consultant (7)
- ☐ ICT infrastructure provider (9)
- ☐ Other (8)

Display This Question:

If Which of the following best describes your organization? = Other

Q32 Please specify

_____

Display This Question:

If Which of the following best describes your organization? = Transport Service Provider (TSP)

Q31 What best describes your service as a TSP?

- ☐ Bus (1)
- ☐ Train (2)
- ☐ Tram (3)
- ☐ Scooter/E-scooter (4)
- ☐ Taxi (5)
- ☐ Bike/e-bike (6)
- ☐ Car share (7)
- ☐ Bike share (8)
- ☐ Other (10)

Display This Question:

If What best describes your service as a TSP? = Other

Q39 Please specify

_____

X→

country Please select the country in which you are employed?

▼ Afghanistan (1) ... Zimbabwe (1357)

Q27 Which of the following best describes your role in your organisation?

- ○ Director (1)
- ○ Senior Management (CEO, CFO, COO, etc.) (2)
- ○ Manager (3)
- ○ Executive (4)
- ○ Supervisor (5)
- ○ Technical leader or assistance (6)
- ○ Administrative staff (7)
- ○ Researcher (8)
- ○ Other (9)

Display This Question:

If Which of the following best describes your role in your organisation? = Other

Q33 Please specify

_____

Q8 How long have you been involved in MaaS related projects?

- ○ No involvement (1)
- ○ less than 1 year (2)
- ○ 1 - 4 years (3)
- ○ more than 4 years (4)

Q3 Have you or your organization been involved in any MaaS schemes or trials?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If Have you or your organization been involved in any MaaS schemes or trials? = No

Q4 Please name the latest MaaS scheme or trial your organisation is involved in?

_____

Page Break

Q38 Please select the country of operation of that scheme?

▼ Afghanistan (1) ... Zimbabwe (1357)

Q6 Please select the key motives of your organisation to engage in that MaaS scheme (Select all that apply)

- ☐ improving the sales revenue (1)
- ☐ interest to try and engage in emerging technologies (2)
- ☐ engaging in sustainable transport solutions (3)
- ☐ contributing to the societal goals (eg: emission levels, reducing car use, traffic congestion) (4)
- ☐ participation is a mandatory obligation due to the circumstances (6)
- ☐ having overlapping objectives with MaaS (7)
- ☐ Other (8)

Display This Question:

If Please select the key motives of your organisation to engage in that MaaS scheme (Select all that... = Other

Q34 Please specify

_____

Q7 Which of the following best describes your role in that scheme?

- ○ Director (1)
- ○ Senior Management (CEO, CFO, COO, etc.) (2)
- ○ Manager (3)
- ○ Executive (4)
- ○ Supervisor (5)
- ○ Technical leader or assistance (6)
- ○ Administrative staff (7)
- ○ Researcher (8)
- ○ Other (9)

Display This Question:

If Which of the following best describes your role in that scheme? = Other

Q35 Please specify

_____

End of Block: Default Question Block

Start of Block: Please select the extent to which you agree or disagree with below statements.

Q12 To what extent do you agree or disagree with the following statements about the **role of trust** in a MaaS ecosystem?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
All the terms and conditions should be explicitly stated in all contractual agreements. (1)	○	○	○	○	○
Personal trust between employees is essential for inter-organizational trust. (3)	○	○	○	○	○
Without trust, collaboration cannot happen. (4)	○	○	○	○	○
Recommendation on a new partner from an existing partner is essential when entering into MaaS agreements. (5)	○	○	○	○	○

Q13 To what extent do you agree or disagree with the following statements about the **partner's capability**?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
Organizations should consider the reputation of the partners before entering into MaaS partnerships. (1)	○	○	○	○	○
Partners should have synergies in their product/service with MaaS to collaborate. (2)	○	○	○	○	○
It is appropriate for partners to be involved in MaaS as a learning opportunity. (3)	○	○	○	○	○
Highly capable partners can fail if they do not receive the required support from other partners. (4)	○	○	○	○	○
MaaS schemes should have partners covering all stakeholder groups. (5)	○	○	○	○	○
MaaS schemes that have few partners from selected stakeholder groups cannot succeed. (7)	○	○	○	○	○

Page Break

Q14 To what extent do you agree or disagree with the following statements about the **level** of **communication and transparency within** a MaaS ecosystem?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
All transport service providers should be informed about the key strategic directions of the MaaS scheme. (1)	○	○	○	○	○
MaaS operators should maintain frequent communication with every stakeholder. (2)	○	○	○	○	○
Agreements among the partners should be visible to all stakeholders. (3)	○	○	○	○	○
Data and information about the MaaS scheme should be available to all the partners. (4)	○	○	○	○	○

Page Break

Q15 To what extent do you agree or disagree with the following statements about the **partners' understanding** of MaaS?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
Collaboration can still happen without having a common understanding. (1)	○	○	○	○	○
All stakeholders should share a common understanding of MaaS. (2)	○	○	○	○	○
Expectations management should be a regular exercise in MaaS developments. (4)	○	○	○	○	○
Different partners who have different interpretations of MaaS can work together. (5)	○	○	○	○	○

Q16 To what extent do you agree or disagree with the following statements about the importance of **open data and APIs**?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
All transport service providers should develop their APIs to be compatible with MaaS. (1)	○	○	○	○	○
APIs should be both open and compatible to realize MaaS. (2)	○	○	○	○	○
Open APIs are not a threat to data security. (3)	○	○	○	○	○
Opening the APIs depends on the nature of other partnering organizations. (4)	○	○	○	○	○
The cost of API development should be recovered from MaaS revenue. (5)	○	○	○	○	○

Q17 To what extent do you agree or disagree with the following statements about **prior relationships** among the partners?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
Prior relationships are an added advantage in working with partners. (1)	○	○	○	○	○
Prior commercial relationships have an edge over other prior relationships. (2)	○	○	○	○	○
Understanding the partner before developing a business relationship is important. (3)	○	○	○	○	○
Prior relationship with the partner is needed to build trust. (4)	○	○	○	○	○
Prior relationships need to have a considerable temporal history. (6)	○	○	○	○	○

Page Break

Q18 To what extent do you agree or disagree with the following statements about **MaaS contracts**?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly disagree (5)
Open market ecosystems without government intervention work best for MaaS developments. (2)	○	○	○	○	○
MaaS contracts must be flexible to accommodate changes. (3)	○	○	○	○	○
Contracts create accountability. (4)	○	○	○	○	○
Clearly defined roles and responsibilities for a partner improve their accountability (5)	○	○	○	○	○

Q19 To what extent do you agree or disagree with the following statements about the MaaS **regulatory environment**?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
Regulatory authorities should set the vision for MaaS. (1)	○	○	○	○	○
Regulation should set open data standards. (2)	○	○	○	○	○
Regulation should enforce open data standards. (4)	○	○	○	○	○
Regulation should enforce fair contracts. (3)	○	○	○	○	○
Regulatory Authorities should enable MaaS developments. (5)	○	○	○	○	○
Regulatory authorities should have a passive involvement in MaaS. (6)	○	○	○	○	○

Q20 Put yourself into the position of a **Transport Service Provider (TSP)**, to what extent do you agree or disagree with the following statements?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
TSPs should open up their APIs to realise MaaS. (1)	○	○	○	○	○
Increasing volume is the main motive of TSPs. (2)	○	○	○	○	○
MaaS is an effective sales channel. (3)	○	○	○	○	○
Investing to develop a good API would be beneficial when joining MaaS. (4)	○	○	○	○	○
TSP must provide discounts as a condition of joining MaaS. (5)	○	○	○	○	○
MaaS objectives should align with the organizational motives of TSPs. (7)	○	○	○	○	○

Page Break

Q21 To what extent do you agree or disagree with the following statements about the **roles of the Public Transport Authority (PTA)**?

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
PTA should regulate the MaaS developments. (1)	○	○	○	○	○
PTA should be the MaaS operator. (2)	○	○	○	○	○
PTA should be actively involved in MaaS development. (3)	○	○	○	○	○
PTA can enable public transport as the backbone of MaaS offers. (4)	○	○	○	○	○
The involvement of PTA retards the MaaS developments. (5)	○	○	○	○	○
If PTA runs MaaS it creates more confidence among stakeholders. (6)	○	○	○	○	○

Q22 To what extent do you agree or disagree with the following statements about **collaboration** within a MaaS ecosystem?

	Strongly agree (11)	Agree (12)	Neutral (13)	Disagree (14)	Strongly Disagree (15)
MaaS itself is a result of collaboration. (1)	○	○	○	○	○
There should be synergies between partners to collaborate with each other. (2)	○	○	○	○	○
Competing TSPs could collaborate on the same platform. (3)	○	○	○	○	○
Collaborating with competitors can be beneficial. (4)	○	○	○	○	○
Collaboration would allow firms to go beyond the contractual obligations. (5)	○	○	○	○	○
Open negotiations lead to win-win solutions. (6)	○	○	○	○	○

Q23 To what extent do you agree or disagree with the following statements about the **societal motives** (reduced emissions, reduced traffic congestion and getting away from car use) of MaaS?

	Strongly agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
The main aim of MaaS is societal motives. (1)	○	○	○	○	○
Societal motives should stay on top of commercial motives. (2)	○	○	○	○	○
The government needs to subsidise the MaaS developments considering the societal goals that it delivers. (3)	○	○	○	○	○
Societal benefits of MaaS must be measurable. (4)	○	○	○	○	○

Page Break

Q24 To what extent do you agree or disagree with the following statements about the **current status of MaaS**?

	Strongly agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
MaaS is still in the stage of development. (1)	○	○	○	○	○
MaaS should be operated by a commercial entity. (2)	○	○	○	○	○
MaaS can stand alone as a commercially viable solution. (3)	○	○	○	○	○
Government should subsidise MaaS in return for the societal benefits it receives. (4)	○	○	○	○	○
MaaS is on the correct innovation trajectory. (5)	○	○	○	○	○
Blockchain technology based MaaS system (where TSPs have direct contracts with users - no intermediary) could solve trust issues in MaaS. (6)	○	○	○	○	○
MaaS should go beyond mobility services to offer entertainment, food, etc. (7)	○	○	○	○	○

Q25 To what extent do you agree or disagree with the following statements about the partners' mutual understanding?

	Strongly agree (13)	Agree (14)	Neutral (15)	Disagree (16)	Strongly Disagree (17)
Partners should be aware of the motives of other partners. (1)	○	○	○	○	○
Commercial motives need to be prioritized if that's what the partners need. (2)	○	○	○	○	○
Some partners may be dominant given their roles in the ecosystem. (3)	○	○	○	○	○
Partners should know each other's capabilities before joining the ecosystem. (4)	○	○	○	○	○
Identifying synergies creates win-win solutions. (5)	○	○	○	○	○
Open negotiations lead to win-win solutions. (6)	○	○	○	○	○

Page Break

Q26 To what extent do you agree or disagree with the following statements about the need for a **MaaS champion**?

	Strongly agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
Collaboration in MaaS needs a leading organization. (1)	○	○	○	○	○
There should be an organisation that connects all stakeholders together. (2)	○	○	○	○	○
MaaS operator needs to lead the MaaS schemes. (3)	○	○	○	○	○
Some stakeholders are better at leading MaaS solutions given their role and exposure. (4)	○	○	○	○	○

Q27 To what extent do you agree or disagree with the following statements about the **conflicts that arise** within a MaaS ecosystem?

	Strongly agree (21)	Agree (22)	Neutral (23)	Disagree (24)	Strongly Disagree (25)
Conflicts will happen in any MaaS ecosystem. (2)	○	○	○	○	○
Varying stakeholder motives can lead to conflicts. (5)	○	○	○	○	○
MaaS models cannot go ahead with conflicts. (7)	○	○	○	○	○
The most influential partners should be given the chance in case of conflict. (8)	○	○	○	○	○

Q28 To what extent do you agree or disagree with the following statements about the **expected outcomes of collaboration** within a MaaS ecosystem?

	Strongly agree (21)	Agree (22)	Neutral (23)	Disagree (24)	Strongly Disagree (25)
Collaboration can create a level playing field. (2)	○	○	○	○	○
Continuous innovation is an output of collaboration. (5)	○	○	○	○	○
Collaboration can make competing partners work for a common goal. (6)	○	○	○	○	○
Collaboration can thrive in teamwork. (7)	○	○	○	○	○
Collaboration drives partners to provide extra commitment. (8)	○	○	○	○	○
Collaboration creates new solutions and ideas. (11)	○	○	○	○	○

Q31 Please leave a brief comment on the importance of building trust and collaboration among the stakeholders in a MaaS ecosystem. You may want to reflect on your own experience.

_____

End of Block: Please select the extent to which you agree or disagree with below statements.

Start of Block:

Q27 Thank you for completing this survey. If you wish to receive a summary of the survey findings please insert your email.

_____

APPENDIX C

Ethics Approval – Phase I

THE UNIVERSITY OF SYDNEY

Research Integrity & Ethics Administration
HUMAN RESEARCH ETHICS COMMITTEE

Wednesday, 23 June 2021

Prof John Nelson
Institute of Transport and Logistics Studies (ITLS); University of Sydney Business School
Email: j.nelson@sydney.edu.au

Dear John,

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

I am pleased to inform you that after consideration of your response, your project has been approved.

Details of the approval are as follows:

Project No.:	**2021/402**
Project Title:	**How can we build trust and collaboration among Mobility as a Service(MaaS) stakeholders**
Authorised Personnel:	**Nelson John; Ho Chinh Quoc; Kandanaarachchi Haupe;**
Approval Period:	**23 June 2021** to **23 June 2025**
First Annual Report Due:	**23 June 2022**

Documents Approved:

Date Uploaded	Version Number	Document Name
17/06/2021	Version 1	Initial Email and Introductory Document
17/06/2021	Version 1	Participant Consent Form
17/06/2021	Version 1	Semi-structured Questions
17/06/2021	Version 1	Participant Information statement
08/04/2021	Version 1	Tentative Time Plan

Condition/s of Approval

- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
  - Serious or unexpected adverse events (which should be reported within 72 hours).
  - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).
- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.
- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.
- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of*

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Research, applicable legal requirements, and with University policies, procedures and governance requirements.

- The Ethics Office may conduct audits on approved projects.
- The Chief Investigator has ultimate responsibility for the conduct of the research and is responsible for ensuring all others involved will conduct the research in accordance with the above.

This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Sincerely,

[redacted]

Dr Haryana Dillon
Chair
Human Research Ethics Committee (HREC 3)

The University of Sydney of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2018) and the NHMRC's Australian Code for the Responsible Conduct of Research (2018)

APPENDIX D

Ethics Approval – Phase II

THE UNIVERSITY OF SYDNEY

Research Integrity & Ethics Administration
HUMAN RESEARCH ETHICS COMMITTEE

Monday, 23 May 2022

Prof John Nelson
Institute of Transport and Logistics Studies (ITLS); University of Sydney Business School
Email: j.nelson@sydney.edu.au

Dear John,

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

I am pleased to inform you that after consideration of your response, your project has been approved.

Details of the approval are as follows:

Project No.:	**2022/219**
Project Title:	**Building trust and collaboration among the stakeholders in a MaaS ecosystem**
Authorised Personnel:	**Nelson John; Ho Chinh Quoc; Kandanaarachchi Thiranjaya;**
Approval Period:	**23/05/2022 to 23/05/2026**
First Annual Report Due:	**23/05/2023**

Documents Approved:

Date Uploaded	Version Number	Document Name
17/05/2022	Version 1.2	Sample Email
12/05/2022	Version 1.1	Participant information Statement V1.1
09/03/2022	Version 1	Survey Questionnaire
09/03/2022	Version 1	Time plan

Condition/s of Approval

- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
  - Serious or unexpected adverse events (which should be reported within 72 hours).
  - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).
- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.
- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.
- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of*

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Research, applicable legal requirements, and with University policies, procedures and governance requirements.

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This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Sincerely,

[redacted]

Associate Professor Helen Mitchell
Chair
Human Research Ethics Committee (HREC 1)

The University of Sydney of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2018) and the NHMRC's Australian Code for the Responsible Conduct of Research (2018)