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UNDERSTANDING MOBILITY AS A SERVICE (MAAS) AND ITS POTENTIAL FOR ENABLING SUSTAINABLE TRAVEL BEHAVIOUR

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ABSTRACT

The establishment of automobile-centred mobility paradigm over the past decades resulted in significant degradation of social, economic, and environmental sustainability. Mobility as a Service (MaaS) is a novel concept that aims to create a shift in individuals' travel behaviour away from private car dependence maximising the potential of alternative modes. Recent research suggests, however, that transport users are not yet ready to abandon their cars while those who intend to use MaaS may fully substitute not only personal car trips but also public transport journeys with car-based shared use mobility services. This means that MaaS penetration, contrary to expectations, may result in unsustainable travel practices among its users and further aggravate transport related sustainability issues. Therefore, this thesis makes its purpose to develop an in-depth understanding of potential travel behavioural implications of MaaS identifying opportunities and challenges in its ability to create sustainable travel behavioural change and produce evidence-based recommendations for policy makers and mobility providers to support sustainable travel behaviour with MaaS.

This study meets its aim by employing a two-stage consequential mixed-methods approach. The first stage is qualitative and targets 40 transport users residing in three different locations around the UK, namely London, Birmingham, and Huddersfield. The data is collected via semi-structured individual interviews and examined using Thematic Analysis. The second research stage comprises of an online quantitative survey, developed using the findings of the literature review and the Thematic Analysis results. A total of 427 useable responses from UK general public were collected and worked through using a combination of Univariate Analysis and Principal Component Analysis followed by Ordinal Regression Modelling.

Thematic Analysis has resulted in identification of five important themes affecting and reflecting user intention to commit to sustainable travel with MaaS – Car Dependence; Trust; Human Element Externalities; Value; and Cost, – each of them with distinctive dimensions, expressed as their sub-themes. Forty attitudinal Likert-Scale statements, pertaining to the Thematic Analysis results, were developed and tested at the surveying stage. After undergoing Principal Component Analysis, the attitudinal statements formed eight MaaS attitudinal factors, with the five core themes developed through Thematic Analysis retained and some of their sub-themes becoming independent. The relationships and dynamics between the eight factors, complemented by socio-demographic and past behaviour items, and MaaS induced travel behavioural intentions were explored using Ordinal Regression.

Univariate Analysis confirmed that just about 19% of transport users in the United Kingdom would consider not owning a car when equipped with MaaS, while circa 60% agreed they would replace some of their public transport trips with car-based shared use mobility options. Ordinal Regression Modelling demonstrated the ability of the eight factors, combined with past behaviour and, in some cases, socio-demographic variables, to explain circa 40% of variance in these behavioural intentions, with Value, Human Element Externalities, Trust, Cost, and Car Ownership dimension of Car Dependence being the most commonly appearing significant predictors. These findings are used to produce evidence-based policy recommendations, targeting MaaS related individual attitudes and past travel practices, that will help making MaaS an effective tool for enabling sustainable travel behaviour among transport users.

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Upon completion of Teaching Assistant Preparation Programme (TAPP), Elena took on a teaching assistant role at Huddersfield Business School and delivered lectures on Transport Challenges and Issues to First Year, and lectures on Transport Economics and Policy to Final Year undergraduate students. In addition, she contributed to the curriculum of postgraduate level Artificial Intelligence and Mobility course, and fully developed and delivered a lecture on Mobility as a Service. Now, Elena is looking forward to starting her full-time role as a Lecturer in Transport at her alma-mater and becoming an even stronger contributor to school's teaching and research excellence.

LIST OF PUBLICATIONS

Journal Papers

Alyavina, E., Nikitas, A., & Njoya Tchouamou, E. (2022). Mobility as a service (MaaS): A thematic map of challenges and opportunities. *Research in Transportation Business & Management,* 100783. https://doi.org/10.1016/j.rtbm.2022.100783

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Nikitas, A., Kougias, I., **Alyavina, E.,** & Njoya Tchouamou, E. (2017). How Can Autonomous and Connected Vehicles, Electromobility, BRT, Hyperloop, Shared Use Mobility and Mobility-As-A-Service Shape Transport Futures for the Context of Smart Cities? *Urban Science, 1*(36). https://doi.org/10.3390/urbansci1040036

Conference Papers

Alyavina, E., Nikitas, A., & Njoya Tchouamou, E. (2021, August 16-20). *Understanding user perceptions of Mobility as a Service (MaaS): Implications for Concept Adoption and Modal Choice.* Paper presented at the 34th International Geographical Congress (IGU), Istanbul, Turkey.

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CHAPTER 1. INTRODUCTION

1.1. Introduction

Mobility-as-a-Service (MaaS) is a novel concept that aims to create a shift in individuals' travel behaviour away from private car dependence maximising the potential of alternative modes. Recent research suggests, however, that potential MaaS users are not yet ready to abandon their cars while intending to fully substitute not only personal car trips but also public transport journeys with services like carsharing and ride-hailing. This means that MaaS penetration, contrary to expectations, may result in unsustainable travel practices among its users, but the reasons behind these choices have not yet been sufficiently understood. This research effort, therefore, aims to develop the empirical understanding of potential travel behavioural implications of MaaS identifying opportunities and challenges in its ability to create sustainable travel behavioural change, and produce evidence-based recommendations for policy makers and mobility providers to support sustainable travel behaviour with MaaS.

This Chapter specifically introduces the rationale behind this study. It starts by providing an overview of current trends in personal mobility, such as shared use mobility and digitalisation of transport, and how those lead to the development of Mobility as a Service (MaaS). This is followed by an overview of implications of shared use mobility and digital transport services for mode choice decisions of transport users. Thereby, this Chapter identifies some of the key research gaps that this work aims to address and, consequently, sets and elaborates on this study's aim and the research objectives. The Chapter ends with an overview of the Thesis structure.

1.2. Study Background

A car-centric transport paradigm has been the foundation of urban growth on a worldwide scale for decades now, which, despite its 'user convenience' merits, has been associated with severely adverse effects on the grounds of social, environmental, and economic sustainability (Nikitas et al., 2018). Hence, planning bodies are looking for means of enabling people to travel responsibly (Kamargianni et al., 2016), and that includes a willingness to try new developments of existing technologies, and to take advantage of digitisation developments that facilitate new business models. Policies, such as congestion charging, have also been developed to reduce car traffic and promote modal shift, but the consequent improvements in terms of car use, resulting from these,

differ significantly from place to place (Cavallaro et al., 2018). Moreover, the acceptance of such policies among members of public is low (Li & Hensher, 2013). As governmental efforts alone cannot overcome car-caused challenges, new means of promoting a change in individuals' travel behaviour are sought-for.

1.2.1. Introducing Novel Mobility Tools

Public transport has been an indispensable part of transport systems for decades, offering mobility services by a variety of modes, including buses and trolleybuses (McLeod et al., 2017), trams and metro systems, or even boats and ferries, that convey a large amount of people simultaneously and provide the foundation for most other forms of mobility (SUMC, 2016). Taxi, defined as a prearranged transportation service for compensation that can be street hailed or scheduled in advance through a phone dispatch, website, or nowadays also a smartphone app (Shaheen et al., 2020), serves as a supplement to public transit, solving the last-mile issues and substituting for public transport when necessary. Yet, a variety of other transportation modes exist. What their underlying principles have in common is that they operate in sharing economy (or, according to Eckhardt & Bardhi (2015), access economy), an economic system where ownership is replaced by access to products and services on an "as needed" basis (Nikitas et al., 2017), enabled via recent digitalisation advancements (Shaheen & Cohen, 2019) – the simultaneous availability of wireless connection, 3G/4G/5G networks and interfaces, such as smartphones and tablets (Goodall et al., 2017). These mobility services add to the efficiency, flexibility and convenience of public transport, help connect with other forms of transport delivering first- and last-mile solutions, create independence for those who cannot afford buying a car, and cut down costs of transport for individuals and households (Nikitas et al., 2017), thus making transport more accessible. Sharing of transportation is also considered to promote sustainability through a more efficient use of tangible and intangible resources (Plewnia & Guenther, 2018). Moreover, it is argued to have huge environmental potential as it is believed to lower traffic congestion by reducing car ownership and private car use levels, thereby also optimising fuel consumption, and mitigating air pollution (DeMaio, 2009; Nikitas et al., 2017).

So, the idea of ride-hailing, also known as ride-sourcing and TNCs, is the same to that of taxi services, however the drivers and passengers connect exclusively via digital applications, used also for booking, electronic payment, and ratings (Shaheen & Cohen, 2019). Carsharing allows individuals to gain temporary access to a vehicle without the costs and responsibilities of

ownership: the costs of fuel and insurance, the maintenance of the vehicle and even parking are made away (Shaheen et al., 2020). Essentially, the given access to a vehicle is short-term usually at an hourly basis (Nikitas et al., 2017). Carsharing schemes come station based, return or one-way, but also peer-to-peer (Shaheen et al., 2020) and can be accessed via smartphone applications. Ride-sharing, often referred to as carpool, involves sharing of rides between drivers and passengers with similar origins and destinations (Shaheen & Cohen, 2019). Such an arrangement provides additional travel options for transport users while allowing drivers to fill otherwise empty seats in their vehicles (SUMC, 2016). When sharing rides, service users split the costs of travel, such as fuel expenses, toll charges, and parking fees, between each other (Shaheen et al., 2020). Micromobility services, such as bike- and scooter-sharing, offer the public hourly access to a fleet of bikes or scooters, either regular or electronic, available at stands or "docklessly" throughout a city (DeMaio, 2009; Nikitas et al., 2018; Shaheen & Cohen, 2019). Access to these services via apps offers users the benefit of finding the nearest pick-up location, ensuring minimum walking time, but also booking and paying for the services at the convenience of their mobile phone.

While the access to the shared mobility services is made easy through smartphone apps, the use of, for example, a bike-sharing or ride-hailing service alone is sometimes insufficient to satisfy the needs of a traveller. For a door-to-door trip, several mobility services must be combined. Such issues with planning a multimodal trip potentiated the emergence of intermodal journey planners - centralised digital platforms that assemble information on various transport means (Kamargianni et al., 2016). Such digital services combine current transit schedules for public transit with information on alternative modes and intelligently link these to create both unimodal and multimodal itineraries, encouraging travellers to make the best use of all available transport modes and supporting an integrated, sustainable transport system (Pronello et al., 2016).

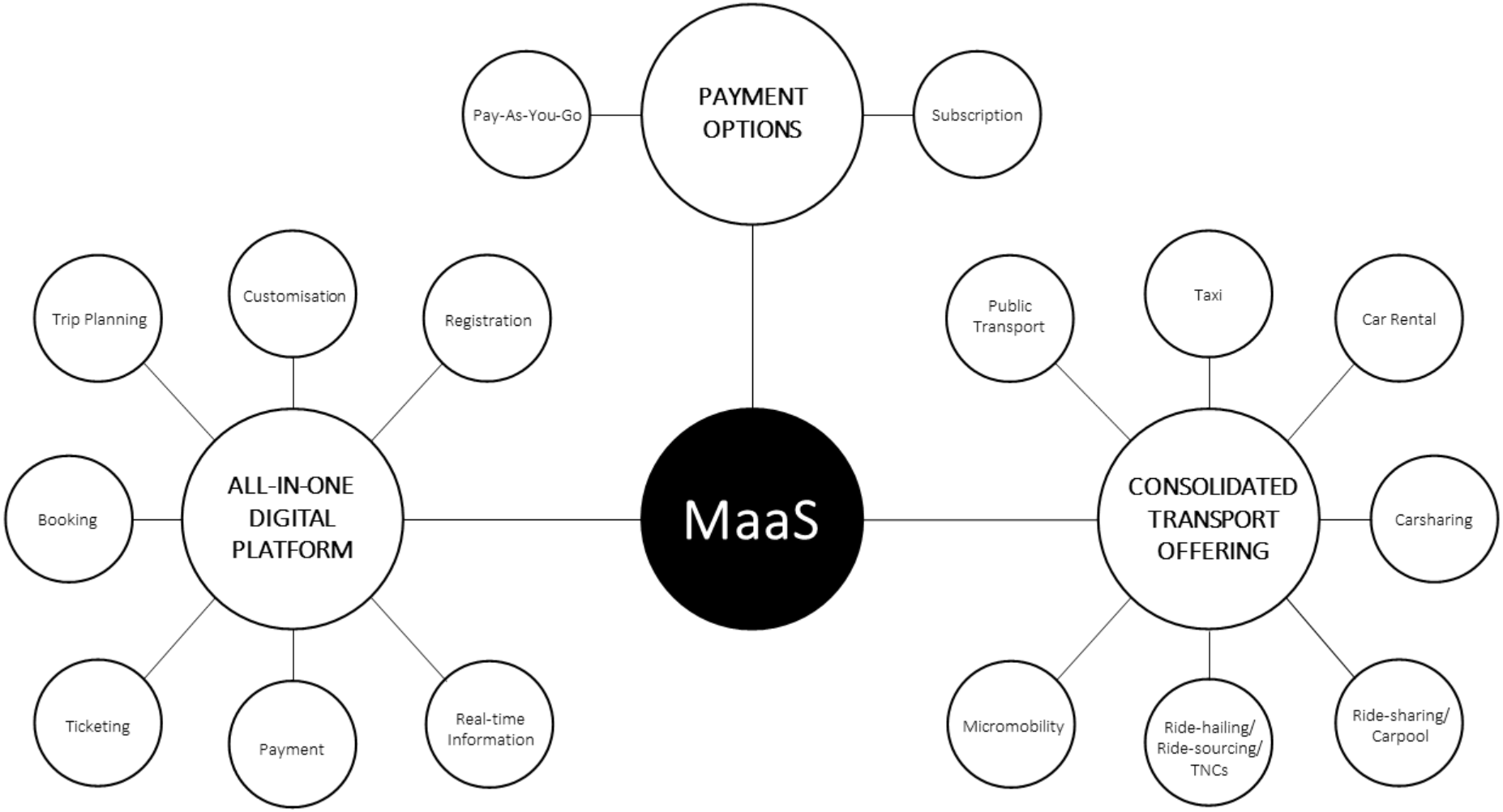
1.2.2. Towards Mobility as a Service

The concept of MaaS derives from both the sharing economy and transport digitalisation trends (Mulley, 2017), and is a natural fit with a lifestyle emerging among younger generations, who nowadays drive less, are more enthused about the latest technological products and alternative forms of mobility and are less likely to learn to drive or own a car (Lyons et al., 2020; Mulley, 2017). Wireless connectivity, technology savviness but also, as Lee et al. (2020) suggested, the impact of the economic crisis and fundamentally different travel preferences from those of older birth cohorts led the younger traveller to open up to digitally enabled shared mobility. Yet, shared use

mobility services are unimodal in their nature, and create barriers to older users and others discouraged by the complexities associated with such procedures (Kamargianni et al., 2016), and to those still resistant to abandon the era of the privately owned vehicle (Nikitas et al., 2019).

Thus, MaaS is a concept that aims to integrate a variety of transportation options into a single on-demand mobility service accessible via a single digital interface, all to beat private car convenience and overcome the need to own a private car among transport users. A number of studies have already tried to provide a comprehensive list of available MaaS definitions (Jittrapirom et al., 2017; Sochor et al., 2018; Oliveira Cruz & Miranda Sarmento, 2020), and its distinguishing characteristics (Arias-Molinares & García-Palomares, 2020; Casady, 2020; Jittrapirom et al., 2017; Mulley, 2017; Utriainen & Pöllänen; 2018; Wong et al., 2020). Generally, consolidated transport offering is identified as one of the major MaaS distinguishing features: the idea behind MaaS is to seamlessly integrate conventional public transport services with shared use mobility alternatives, and even walking. The integrated transport services can be offered in a bundle form, where the volume of use of different transport modes is customised to specific user needs. The access to a multitude of transport options with MaaS is facilitated by all-in-one digital platform, e.g., a smartphone application, which in itself is an intermodal journey planner offering booking and ticketing of, and payment for the journey all in one place, as well as the provision of real-time information necessary to overcome issues arising on-route. The use of a digital platform implies registration requirement, where the user creates an account to access the available within MaaS mobility services. MaaS can serve user needs on a pay-as-you-go basis and as a periodic subscription for mobility bundles, thus offering a variety of payment options. These are the features explaining MaaS and presented on Figure 1.2.1.

Figure 1.2.1: Explaining MaaS



1.3. Study Purpose

Recent research findings suggest that shared use mobility services have dubious effects on individual transport choices in terms of sustainability. A number of studies have investigated the mode choice implications of ride-hailing services across the world, with some of them showcasing evidence of service's positive impact on mode choice decisions. The study of ride-hailing use in Texas (Lavieri & Bhat, 2019), for an instance, found that almost a half (46.25%) of ride-hailing customers used the service as a substitute for personal car trips; yet circa 10% of them substituted public transport trips with the service, and almost 6% would not make the trip should the service be unavailable, implying the new trip generation implications. Having asked whether the trip would still take place should ride-hailing be unavailable, Rayle et al. (2016), similarly, found that 8% of service users in San-Francisco would not travel at all; of those who would still travel, a total of 39% would have used a taxi, and 6% would drive their personal car instead, while a large 33% would have used public transport. Henao & Marshall (2019) discovered that 19% of ride-hailing trips in Denver, Colorado, would have been single-occupancy vehicle trips while 34% would have been walked, almost 12% would be cycled, over 22% done using public transport, and more than 12% would not have been taken had the services not existed. While 15% of existing ride-hailing users in Santiago de Chile reported the use of the service as a substitute for personal car trips, over 37% reported the service was used as a substitute for public transport trips, and over 5% stated they would not make a trip at all be ride-hailing unavailable; moreover, the service almost unanimously (96%) was used without combining it with other modes of transport (Tirachini & del Rio, 2019), suggesting poor last-mile potential and poor ability to increase multimodality. Moreover, Barajas & Brown (2021) found little evidence for ride-hailing trips in Chicago to serve the areas with low level of public transport service; the authors suggest that ride-hailing services actually serve dense urban areas and city centres with good public transport provision, thereby not actually filling the gaps in service provision. As for ride-hailing's implications for car ownership, Bekka et al. (2020) found the presence of ride-hailing service Uber, though alongside other factors, to have an influence on the decision to get rid of personal car in Paris; though, only circa 4% of all Uber users in the area abandoned their household cars in the four years the service had been available. In San Francisco, as many as 90% of car-owning ride-hailing users did not change their car ownership levels since they began using the service (Rayle et al., 2016).

As for the impact of carsharing on mode choice decisions, the evidence is also twofold. Clewlow (2016), for example, discovered that carsharing members in San Francisco, USA, walk and cycle

more than regular city-based transport users, are, in general, more multimodal, and own significantly fewer cars. Nijland & van Meerkerk (2017) discovered that carsharing users in the Netherlands drove 15% to 20% fewer car kilometres than prior to carsharing, while the shared cars for them were replacing a second or third household car. Due to reduced car ownership and car use, car sharers were also found to emit fewer kilograms of CO2 per person, per year. Becker et al. (2018) found free-floating carsharing to be able to reduce car ownership levels in Basel, Switzerland. Ceccato & Diana (2018) presented evidence that car sharing in Turin can substitute car driving trips and complement the use of public transport. On the other hand, Papu Carrone et al. (2020), having conducted a study in nationwide Denmark, discovered that free-floating carsharing mainly serves as a substitute for public transport trips rather than personal car trips. Picasso et al. (2020) found that as many as 68% of transport users in Buenos Aires prefer carsharing over public transport; moreover, higher preference for the service occurs among people who normally drive their car. Also, Silvestri et al. (2021) found the use of carsharing to generally compete with the use of public transport modes. Little evidence has been found regarding the impact of ride-sharing services on mode choice decisions. On the positive side, Mou et al. (2020) found ride-sharing services to have an influence on car buying decision among non-car owning individuals: by conducting a survey in Jinan, China, the authors found that 12% of respondents would give up the idea of purchasing a car and 22% of them would postpone the purchase. Tirachini et al. (2020), by conducting a study in Mexico have, however, found that almost 37% of trips replaced with ride-sharing services were previously executed by public transport modes, while only 11% were executed by personal car.

The literature suggests that mode choice effects of bike-sharing are also rather poor. A study of bike-sharing schemes in the cities of Melbourne, Brisbane, Washington, D.C., London, and Minneapolis suggests that a substantial proportion of bike-sharing trips substitute for public transport and walking (Fishman et al., 2015). As a result of bike-sharing scheme being introduced public transport ridership also decreased in New York City, USA (Campbell & Brakewood, 2017). In Dublin, Ireland, bike-sharing generally replaced walking trips (77%) while switches from bus and tram accounted for just 16%; only 2% of switches were away from personal car and another 6% from taxi (Bullock et al., 2017). In Ningbo, China, circa 17% of bike-sharing customers used it in place of personal car (Lu et al., 2017). In the Netherlands, only around 35% of bike-sharing customers used their car, either as a driver or passenger, or taxi less as a result of using the service; people mainly turned away from walking (40%) and the use of bus/tram services (45%) when becoming bike-sharing users (Ma et al., 2020). On a good note, though, the evidence suggests that

bike-sharing is generally used as a first-last mile means of transport (Bielinski & Wazna, 2020). As for micromobility, in Paris, for example, as many as 35% of e-scooter users replaced walking with the service, while 27% switched from public transport, 25% switched from bike-sharing, 9% previously used carsharing, and only 4% previously used personal car; moreover, almost 6% of e-scooter trips were induced trips (Christoforou et al., 2021). In Rosslyn, Virginia, USA, again, a large number of e-scooter trips (33%) replaced walking, while 12% replaced cycling, 7% replaced bus trips, and another 7% substituted for personal car trips; though, as many as 39% of e-scooter trips replaced taxi and ride-hailing journeys (James et al., 2019). The e-scooters were used as a first-last mile solution by just 30% of service customers in Tricity, Poland (Bielinski & Wazna, 2020); more often, however, the service was used "for fun".

As for the impact of real-time information and journey planning services, Keynon & Lyons (2003), for example, have found that presenting transport users with a number of modal options for a journey could challenge their previous perceptions of using the car, overcoming habitual and psychological barriers to consideration of alternative modes. A test of an intermodal traveller information service, described in Skoglund & Karlsson (2012), however, resulted in only one testing individual to use personal car less often; moreover, only 9% of testers claimed to have increased their use of public transport as a result of having access to the service. Pronello et al. (2016), who tested an intermodal traveller information service Optymod in Lyon, France, found it unable to induce a shift towards more sustainable mobility: the introduction of the service did not produce any change in the use of personal cars, motorcycles, bicycles, or bike-sharing. Moreover, the number of people using polluting modes slightly increased after the test.

Therefore, it can be concluded that shared use mobility services have rather poor effect on car ownership and personal car use, while decreasing public transport ridership and active travel. Moreover, car-based shared use mobility services add to transport systems, and even double, vehicle miles travelled (Henao & Marshall, 2019; Schaller, 2021), thus worsening overall sustainability. The users of bike-sharing and micromobility, though contributing to reduction of emissions due to reduced vehicle miles travelled, are additional users of cycling infrastructure, putting further pressure on the current allocation of road space (Laa & Leth, 2020), while Intermodal journey planners have no real effect on individual transport choices. The presented evidence, therefore, also drives concerns regarding the effectiveness of integrating these individual components in the form of MaaS to beat car convenience and enable a shift away from car ownership and car use among its users.

1.4. Setting Aims and Objectives

Recent research findings suggest that the use of car-based shared use mobility services, such as ride-hailing, carsharing and ride-sharing, is often not an enhancement of other travel modes but rather a full substitute for the journeys that would be otherwise performed by a personal car and, what is worse, by public transit, while services like bike-sharing and shared micromobility do not really target complacent car users but public transport users and active travellers instead, putting further pressure on the already busy transport systems. Furthermore, intermodal journey planners and information systems, as evidence suggests, do not contribute to sustainable modal shift and multimodality. This means that MaaS has the potential, if not designed, implemented, and operated properly, to create exactly the opposite results of the anticipated ones enhancing unsustainable mode choices among its users. Therefore, this scientific inquiry aims to:

Develop the empirical understanding of potential travel behavioural implications of MaaS identifying opportunities and challenges in its ability to create sustainable travel behavioural change and produce evidence-based recommendations for policy makers and mobility providers to support sustainable travel behaviour with MaaS.

Achieving this can happen through fulfilling the following objectives:

(I) To explore the factors underpinning the acceptance and travel behavioural intentions of transport users in response to MaaS identifying challenges and opportunities in creating genuinely sustainable travel behaviour; and

(II) To explore the relationships and dynamics between the factors and MaaS induced acceptance and travel behavioural intentions.

By fulfilling these objectives, the study will not only develop an empirical understanding of MaaS acceptance and travel behavioural implications, but also identify the drivers behind the latter, enabling the author to produce relevant policy recommendations to support sustainable travel behavioural transition to MaaS transport paradigm.

1.5. Overview of Thesis Structure

An overview of the structure of the Thesis follows below summarising what every Chapter is set to contribute to the study.

Chapter 2. Literature Review

The Literature Review is presented in a way that, first, determines what is known about MaaS acceptance and its potential travel behavioural implications, highlighting the controversy in MaaS travel behavioural research and the need for studying it more closely, thus specifying the specific knowledge gap that this thesis aims to address. Then, the theoretical attributes that were used, this far, to explain MaaS acceptance and associated travel behavioural choices are identified, and a preliminary conceptual framework that guides further investigation is developed.

Chapter 3. Methodology

Chapter 3 of the thesis provides an in-depth description of the research methodology, and the reasons behind the methodological choices made. Highlighting the nature of the aim and objectives of this study, but also author's philosophical standing and the strengths of mixed-methods research, the choice of exploratory sequential mixed methods research design is justified. According to this design, the qualitative findings feed into the design of data collection and analysis tools used at the quantitative phase. For the above reason, Chapter 3 Methodology does not describe the tools used for data collection and analysis; neither it provides the overview of data collection and analysis processes. The aim of this chapter is in conceptualising the methods and tools selected, while the overview of the step-by-step processes undertaken, and how the findings of qualitative research phase are used to inform the quantitative phase are provided in the chapters to follow.

Chapter 4. Qualitative Phase and Analysis

This chapter introduces the qualitative phase of the research, presented in this thesis. The chapter is initiated by the discussion of the development of the interview guide and infographic, used for qualitative data collection. Then the step-by-step interviewing, sampling, and data analysis processes are discussed. The chapter also presents the sample profile, and the themes extracted from the interviewees' responses in the form of thematic map, but also in the form of a narrative with thick description using a number of qualitative data extracts. In conclusion, the chapter summarises the key findings of qualitative phase and enhances the conceptual framework, developed via literature review, for further investigation.

Chapter 5. Quantitative Phase and Analysis

This chapter discusses the quantitative phase of this research, from the development of tools for data collection, to the data collection, sampling, and analysis processes. More specifically, the development of quantitative survey instrument, and how the findings of the qualitative phase inform the tool, is presented. Then the chapter describes the way the sample was obtained, and the data were collected. After, the chapter is divided into three analysis and findings sections, starting with the step-by-step description of univariate analysis and its results, followed by exploratory factor analysis and the results, which also fed into the ordinal regression modelling process. The next section is the presentation of six ordinal regression models, with key variables and statistically significant relationships pointed out. The chapter is concluded by a summary of key quantitative findings, and how those inform and adjust the framework of drivers behind MaaS acceptance and travel behavioural intentions.

Chapter 6. Discussion

The Discussion Chapter provides a critical analysis of the empirically generated evidence in a way that fulfils the research objectives. Thereby, the chapter synthesises the findings of this mixed methods research, and compares and enhances these results referring to the existing body of the literature, identified via a pre-analysis as well as post-analysis literature review. This way, a detailed empirical understanding of MaaS travel behavioural implications, and the factors that underpin MaaS acceptance and travel behavioural intentions, is developed.

Chapter 7. Conclusion

This chapter finalises the thesis by delivering the key messages of mixed methods investigation and based on the latter, generating recommendations for policy makers and transport and mobility providers, thus fulfilling the overall aim of the thesis. The chapter also specifies the specific contributions of this thesis to theory, practice, and methodology. The recommendations for future research complete the chapter.

CHAPTER 2. LITERATURE REVIEW

2.1. Introduction

This Chapter reviews the existing literature focusing on issues relevant to the topic under investigation. A review of prior literature is an essential feature of any academic work that creates a firm foundation for advancing knowledge, facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where the research is needed (Webster & Watson, 2002). Conducting a literature review also informs the researcher of the influential authors in the field (Randolph, 2009). This literature review, therefore, serves the following purpose:

1. *Review the state-of-the-art literature to determine what is known about MaaS acceptance and its potential travel behavioural outcomes;*

2. *Identify theoretical attributes used to explain MaaS acceptance and travel behaviour to generate a conceptual framework for further investigation.*

According to Cooper's (1988) Taxonomy of Literature Reviews, presented in the work by Randolph (2009), the present review has two *foci*: the research outcomes of the investigated literature, and theories, both generated and tested. The *goal* of this literature review is, therefore, to integrate and critically analyse the literature to identify the knowledge gap in current research and highlight the need for further investigation. The review itself takes a more or less neutral *perspective*, presenting the research findings as facts (e.g. numbers), but in writing convincing the audience that the travel behavioural controversy in MaaS research does exist. In terms of *coverage*, the number of existing sources on the topic allowed for exhaustive review with selective citation, with a total of 46 items included in the review.

Adopting an approach to review inspired by systematic practices, the author presents the findings of existing MaaS research focusing on both the acceptance of MaaS and what the acceptance of MaaS might mean for travel behavioural intentions of transport users. Identifying controversial, in terms of sustainability, travel behavioural outcomes of shifting to MaaS paradigm, the review then turns its focus on investigating the factors affecting MaaS acceptance and travel behaviour that the literature developed and/or examined, thus reviewing theoretical items explaining MaaS acceptance and travel behaviour. This literature review results in a framework, used to guide further investigation of MaaS travel behavioural implications.

2.2. Search Methodology and Synthesis

The following discussion is the product of a literature review conforming to some key principles of a systematic approach proposed by Van Wee & Banister (2016) but also described in Knowles et al. (2020), Nikitas (2019), and Nikitas et al. (2020). A search in Scopus was conducted using the terms 'Mobility as a Service' and 'MaaS' and the publication date range of 2014 to 2021. This returned 262 English language book chapters, journal articles, and conference papers, which then were thoroughly evaluated.

A number of approaches to evaluation of information sources exist; a good scholarly evaluation, though, needs to integrate multiple perspectives and, more importantly, provide relevant criticism (Hjørland, 2012). Following this view, a total of 262 abstracts were read by the author to evaluate *fitness for purpose* of the literature review, after which 48 sources were retained. The criteria for further retention included, first, the *content* and *trustworthiness* of the source; after, the *publisher reputation* and the *journal impact factor* were also looked at. Thus, the remaining 48 sources were read in full to assess the information provided for uniqueness, relevance, and comprehensiveness in relation to MaaS acceptance and its travel behaviour implications. Upon completion of this step, seven out of 48 items were removed, leaving the base of 41 sources.

To make the search for sources more extensive, in addition to the database search the use of snowballing from reference lists of the already identified sources is recommended (Jalali & Wohlin, 2012). Using this approach, another three items, namely industry reports, were discovered, resulting in total of 44 items retained as relevant. The last step in identifying relevant literature included Google search, where a further two industry reports, were found, bringing this review to a base of 46 items. These 46 literature items were used by the author to discuss MaaS acceptance and critically analyse MaaS travel behavioural implications, and to identify conceptual underpinnings of MaaS acceptance and behavioural intentions to create a conceptual framework for further investigation. Thus, this chapter in its final form discusses MaaS related insights from 46 journal articles, conference papers and industry reports.

The analysis of the selected items resulted in the identification of two topical pillars discussing MaaS in the travel behaviour context, namely the *acceptance* and *travel behavioural outcomes*, and three topical pillars discussing the factors pertaining to potential MaaS users and affecting acceptance of or travel behaviour with MaaS, namely *socio-demographics*, *general attitudes*, and *past behaviour*. All topical pillars are discussed in detail in the sections to follow, with the last three forming the theoretical grounds for further investigation.

2.3. Overview of Identified Studies

Table 2.3.1 lists the identified studies in chronological order. The table provides information on publication dates, authorships, titles, sources, methodologies, and insights. The insights, as can be noted, are divided into two columns, namely *TB Relevance* and *Framework Relevance*, with TB standing for "Travel Behaviour". *TB Relevance* column, thus, contains information on whether the presented paper provides insights on *acceptance* of MaaS and/or the related *travel behavioural outcomes*. The *Framework Relevance* column then lists what was determined as drivers of MaaS acceptance and/or travel behaviour by the authors: *socio-demographics*, general attitudes, or *past behaviour*.

The publication dates for selected papers range from 2015 to 2021, with most papers published in 2020. This, as noted by Butler et al. (2020), reflects the growing interest of academia and industry in the MaaS concept. Most selected studies were published in peer reviewed journals (39); other studies included conference papers (2) and industry reports (5). Surveys (23), including SP experiments, were the most popular methods used, followed by pilot studies (13), purely qualitative work (5), and mixed methods studies combining surveys and interviews/focus groups (3). A mix of survey and simulation methodology (1), and big data analysis (1) were also present. The identified studies focus on transport users in across Europe, including the UK and Switzerland, as well as Australia, China, and the USA.

Table 2.3.1: Overview of Publications included in the Literature Review (in chronological order)

Year	Author(s)	Title	Source	Method (Sample)	Location	TB Relevance	Framework Relevance
2015	Smile Mobility	Smile Einfach Mobil: Pilot Operation and Study	Industry Report	Pilot (N>1,000) + Survey (N~170)	Vienna, Austria	Travel Behavioural Outcomes	N/A
2015	Sochor et al.	Implementing Mobility as a Service: Challenges in Integrating User, Commercial, and Societal Perspectives	Transportation Research Record	Pilot (N=195) + Survey (N=160) + Interviews/ Focus groups/ Workshops	Gothenburg, Sweden	Travel Behavioural Outcomes	General Attitudes
2016	Sochor et al.	Trying Out Mobility as a Service: Experiences from a Field Trial and Implications for Understanding Demand	Transportation Research Record	Pilot (N=195) + Survey (N=160) + Interviews/ Focus groups/Workshops	Gothenburg, Sweden	Travel Behavioural Outcomes	General Attitudes
2017	Alonso-González et al.	Urban Demand Responsive Transport in the Mobility as a Service Ecosystem: Its Role and Potential Market Share	Thredbo 15: Competition and Ownership in Land Passenger Transport	Survey (N=797)	Netherlands	Acceptance	Socio-Demographics; General Attitudes; Past Behaviour
2018	ESP Group	NaviGoGo - Scotland's first MaaS pilot	Industry Report	Pilot (N=98) + Survey (N=98)	Dundee and North-East Fife, Scotland, UK	Travel Behavioural Outcomes	N/A
2018	Ho et al.	Potential uptake and willingness-to-pay for Mobility as a Service (MaaS): A stated choice study	Transportation Research Part A: Policy and Practice	Survey (N=252)	Sydney, Australia	Acceptance	Socio-Demographics; General Attitudes; Past Behaviour
2018	Kamargianni et al.	Londoners' attitudes towards car-ownership and Mobility-as-a-Service: Impact assessment and opportunities that lie ahead	Industry Report	Survey (N=1,570)	London, UK	Travel Behavioural Outcomes	N/A
2018	Keller et al.	Car Sharers' Interest in Integrated Multimodal Mobility Platforms: A Diffusion of Innovations Perspective	Sustainability (MDPI)	Survey (N=711)	Germany	Acceptance	General Attitudes
2018	Matyas & Kamargianni	The potential of mobility as a service bundles as a mobility management tool	Transportation	Survey (N=1,068)	London, UK	Acceptance	Socio-Demographics; Past Behaviour

Table 2.3.1 (Continued): Overview of Publications included in the Literature Review (in chronological order)

Year	Author(s)	Title	Source	Method (Sample)	Location	TB Relevance	Framework Relevance
2018	Strömberg et al.	Inviting travelers to the smorgasbord of sustainable urban transport: evidence from a MaaS field trial	Transportation	Pilot (N=195) + Survey (N=160) + Interviews/ Focus groups/ Work-shops	Gothenburg, Sweden	Travel Behavioural Outcomes	N/A
2018	Wright et al.	Public acceptance of SocialCar, a new mobility platform integrating public transport and car-pooling services: in-sights from a survey in five European cities	Proceedings of 7th Transport Research Arena TRA 2018	Survey (N=1,072)	Brussels, Belgium Edinburgh, UK Ticino, Switzerland Ljubljana, Slovenia Zagreb, Croatia	Travel Behavioural Outcomes	Socio-Demographics; General Attitudes
2019	Fioreze et al.	On the likelihood of using Mobility-as-a-Service: A case study on innovative mobility services among residents in the Netherlands	Case Studies on Transport Policy	Survey (N=568) + Focus Groups (N=15)	's-Hertogenbosch, Netherlands	Acceptance	Socio-Demographics; General Attitudes; Past Behaviour
2019	Hartikainen et al.	Whimpact: Insights from the world's first Mobility-as-a-Service (MaaS) sys-tem	Industry Report	Big Data Research		Acceptance; Travel Behavioural Outcomes	N/A
2019	UITP	Mobility as a Service	Industry Report	Pilot (N=39) + Interviews (N=39)	Manchester, UK	Travel Behavioural Outcomes	N/A
2020	Alonso-González et al.	Drivers and barriers in adopting Mobil-ity as a Service (MaaS) – A latent class cluster analysis of attitudes	Transportation Research Part A: Policy and Practice	Survey (N=1,006)	Netherlands	Acceptance	Socio-Demographics; General Attitudes; Past Behaviour
2020	Biehl & Stathopoulos	Investigating the interconnectedness of active transportation and public transit usage as a primer for Mobility-as-a-Ser-vice adoption and deployment	Journal of Transport & Health	Survey (N=826)	Midwestern U.S. states	N/A	General Attitudes; Past Behaviour
2020	Caiati et al.	Bundling, pricing schemes and extra features preferences for mobility as a service: Sequential portfolio choice ex-periment	Transportation Research Part A: Policy and Practice	Survey (N=1,078)	Eindhoven and Amsterdam, Netherlands	Acceptance	Socio-Demographics; General Attitudes; Past Behaviour
2020	Gairal Casadó et al.	Children, Young people and Mobility as a Service: Opportunities and barriers for future mobility	Transportation Research Interdisciplinary Perspectives	Workshops (N=20)	Newcastle-upon-Tyne, UK	N/A	General Attitudes

Table 2.3.1 (Continued): Overview of Publications included in the Literature Review (in chronological order)

Year	Author(s)	Title	Source	Method (Sample)	Location	TB Relevance	Framework Relevance
2020	Feneri et al.	Modeling the effect of Mobility-as-a-Service on mode choice decisions	Transportation Letters	Survey (N=1,010)	Rotterdam, Amsterdam, and Utrecht, Netherlands	N/A	Socio-Demographics; General Attitudes; Past Behaviour
2020	Guidon et al.	Transportation service bundling – For whose benefit? Consumer valuation of pure bundling in the passenger transportation market	Transportation Research Part A: Policy and Practice	Survey (N=1,000)	Zurich, Switzerland	Travel Behavioural Outcomes	N/A
2020	Harrison et al.	The Business Case for a Journey Planning and Ticketing App – Comparison between a Simulation Analysis and Real-World Data	Sustainability (MDPI)	Pilot (N~150) + Simulation + Survey	West Yorkshire, UK	Travel Behavioural Outcomes	N/A
2020	Hesselgren et al.	Understanding user practices in mobility service systems: Results from studying large scale corporate MaaS in practice	Travel Behaviour and Society	Pilot (N~3,300) + Interviews (N=77)	Stockholm, Sweden	Travel Behavioural Outcomes	N/A
2020	Ho et al.	Public preferences for mobility as a service: Insights from stated preference surveys	Transportation Research Part A: Policy and Practice	Survey (Sydney N=252; Tyneside N=290)	Sydney, Australia and Tyneside, UK	Acceptance; Travel Behavioural Outcomes	Socio-Demographics; General Attitudes; Past Behaviour
2020	Hoerler et al.	What are the factors and needs promoting mobility-as-a-service? Findings from the Swiss Household Energy Demand Survey (SHEDS)	European Transport Research Review	Survey (N=995)	Switzerland	Acceptance	Socio-Demographics; General Attitudes; Past Behaviour
2020	Jang et al.	Does MaaS contribute to sustainable transportation? A mode choice perspective	International Journal of Sustainable Transportation	Survey (N=1,078)	Eindhoven and Amsterdam, Netherlands	Acceptance	Socio-Demographics; Past Behaviour
2020	Karlsson et al.	Development and implementation of Mobility-as-a-Service – A qualitative study of barriers and enabling factors	Transportation Research Part A: Policy and Practice	Interviews (N=20) + Focus Groups (N=10)	Gothenburg, Sweden	Travel Behavioural Outcomes	General Attitudes; Past Behaviour
2020	Liljamo et al.	People's current mobility costs and willingness to pay for Mobility as a Service offerings	Transportation Research Part A: Policy and Practice	Survey (N=1,176)	Finland	Acceptance	General Attitudes

Table 2.3.1 (Continued): Overview of Publications included in the Literature Review (in chronological order)

Year	Author(s)	Title	Source	Method (Sample)	Location	TB Relevance	Framework Relevance
2020	Lopez-Carreiro et al.	Urban mobility in the digital era: An exploration of travellers' expectations of MaaS mobile-technologies	Technology in Society	Focus Groups (N=51)	Madrid, Spain	N/A	General Attitudes
2020	Matyas	Opportunities and barriers to multimodal cities: lessons learned from in-depth interviews about attitudes towards mobility as a service	European Transport Research Review	Interviews (N=30)	London, UK	N/A	General Attitudes; Past Behaviour
2020	Mola et al.	Mobility as a Service: An Exploratory Study of Consumer Mobility Behaviour	Sustainability (MDPI)	Survey (N=201)	France and Finland	N/A	General Attitudes
2020	Mulley et al.	Mobility as a service in community transport in Australia: Can it provide a sustainable future?	Transportation Research Part A: Policy and Practice	Survey (N=105)	Sydney, Australia	N/A	General Attitudes
2020	Polydoropoulou et al.	Exploring Individual Preferences and Willingness to Pay for Mobility as a Service	Transportation Research Record	Survey (N=449)	Manchester, UK	N/A	Socio-Demographics; General Attitudes
2020	Polydoropoulou et al.	Ready for Mobility as a Service? Insights from stakeholders and end-users	Travel Behaviour and Society	Focus Groups (N=40) + Survey (N=106)	Budapest, Hungary and Manchester, UK	N/A	Socio-Demographics; General Attitudes
2020	Reck & Axhausen	How Much of Which Mode? Using Revealed Preference Data to Design Mobility As a Service Plans	Transportation Research Record	Survey (N=555) + Simulation	Copenhagen, Denmark	Travel Behavioural Outcomes	Past Behaviour
2020	Schikofsky et al.	Exploring motivational mechanisms behind the intention to adopt mobility as a service: Insights from Germany	Transportation Research Part A: Policy and Practice	Interviews (N=24) + Survey (N=1,067)	Germany	N/A	Socio-Demographics; General Attitudes; Past Behaviour
2020	Sjöman et al.	Exploring everyday mobility in a living lab based on economic interventions	European Transport Research Review	Living Lab (N=9)	Stockholm, Sweden	N/A	General Attitudes
2020	Storme et al.	Limitations to the car-substitution effect of MaaS. Findings from a Belgian pilot study	Transportation Research Part A: Policy and Practice	Pilot (N=73) + Survey (N=73)	Ghent, Belgium	Travel Behavioural Outcomes	N/A

Table 2.3.1 (Continued): Overview of Publications included in the Literature Review (in chronological order)

Year	Author(s)	Title	Source	Method (Sample)	Location	TB Relevance	Framework Relevance
2020	Vij et al.	Consumer preferences for Mobility-as-a-Service (MaaS) in Australia	Transportation Research Part C: Emerging Technologies	Survey (N=3,985)	Australia	Acceptance; Travel Behavioural Outcomes	Socio-Demographics
2020	Wright et al.	MaaS for the suburban market: Incorporating carpooling in the mix	Transportation Research Part A: Policy and Practice	Pilot (N=124) + Survey (Before & End of Pilot) (N=124) + Survey (General Public) (N=1,072) + Focus Groups	Brussels, Belgium Edinburgh, UK Ticino, Switzerland Ljubljana, Slovenia	Travel Behavioural Outcomes	Socio-Demographics
2020	Ye et al.	A study on users' willingness to accept mobility as a service based on UTAUT model	Technological Forecasting & Social Change	Survey (N=600)	Shanghai, China	N/A	Socio-Demographics; General Attitudes; Past Behaviour
2020	Zhao et al.	Key barriers in MaaS development and implementation: Lessons learned from testing Corporate MaaS (CMaaS)	Transportation Research Interdisciplinary Perspectives	Pilot (N~3,300) + Survey (N=355)	Stockholm, Sweden	Travel Behavioural Outcomes	N/A
2020	Zijlstra et al.	Early adopters of Mobility-as-a-Service in the Netherlands	Transport Policy	Survey (N=1,547)	Netherlands	N/A	Socio-Demographics; General Attitudes; Past Behaviour
2021	Hensher et al.	Mobility as a service and private car use: Evidence from the Sydney MaaS trial	Transportation Research Part A: Policy and Practice	Pilot (N=92)	Sydney, Australia	Travel Behavioural Outcomes	N/A
2021	Ho et al.	Drivers of participant's choices of monthly mobility bundles: Key behavioural findings from the Sydney Mobility as a Service (MaaS) trial	Transportation Research Part C: Emerging Technologies	Pilot (N=93)	Sydney, Australia	Travel Behavioural Outcomes	Socio-Demographics; General Attitudes; Past Behaviour
2021	Liljamo et al.	The Effects of Mobility as a Service and Autonomous Vehicles on People's Willingness to Own a Car in the Future	Sustainability (MDPI)	Survey (N=1,176)	Finland	Travel Behavioural Outcomes	N/A
2021	Matyas & Kamargianni	Investigating heterogeneity in preferences for Mobility-as-a-Service plans through a latent class choice model	Travel Behaviour and Society	Survey (N=475)	Greater Manchester, UK	Acceptance	Socio-Demographics; Past Behaviour

2.4. MaaS Acceptance and Implications for Travel Behaviour

The studies discussed herein report the findings related to MaaS Acceptance, also referred to as willingness, openness, or inclination to subscribe, adopt or use MaaS, and the potential travel behavioural outcomes of shifting to MaaS based travel. The below discussion is an integration of the results of numerous MaaS pilot studies and live schemes, as well as findings of empirical investigations identified through the literature review process.

2.4.1. Acceptance

Ho et al. (2018; 2020) studied the willingness to subscribe to MaaS among residents of Sydney, Australia. The participants, who were first introduced to MaaS by viewing a video explaining the concept, were then to make a distinction between the proposed mobility packages, evolving around their demographics, personal circumstances and travel patterns, pay-as-you-go option, or no subscription. Interestingly, as many as 53% of study participants chose not to subscribe to MaaS even on a hypothetical level. A similar to the above study also took place in Tyneside, UK (Ho et al., 2020); there, as many as 55% of study participants choose to subscribe to neither a bundle nor a pay-as-you-go MaaS option. By running an online self-administered survey about MaaS in Greater London, UK, Matyas & Kamargianni (2018) discovered that only 403 of 1,068 study participants, or circa 38%, intended to subscribe to MaaS. Keller et al. (2018), who conducted an online survey studying the willingness to adopt MaaS-like integrated multimodal mobility (IMM) platforms among carsharing users in nationwide Germany, found no clear adoption tendency; though, 74% of study participants who never heard of IMM platforms expressed a general interest in using those for their travel needs.

Fioreze et al. (2019) looked at the willingness to use MaaS in the city of 's-Hertogenbosch, Netherlands. A survey, which introduced a concept of MaaS through MaaS app screenshots and asked a series of questions focusing on attitudes towards different transport modes and the intention to use MaaS, was completed by residents of Paleiskwartier, a district of 's-Hertogenbosch. The findings indicated that only 20% of participants were, to some degree, willing to use MaaS be it available to them. As many as 60% of respondents had no interest in using MaaS, while another 20% remained neutral towards the concept. Alonso-González et al. (2020), by surveying a panel of Dutch general public, identified five potential MaaS user clusters. Only two clusters though, or 47% of study participants, were sufficiently inclined to adopt MaaS. Another study (Caiati et al., 2020;

Jang et al., 2020), conducted in the Netherlands, investigated, also through the use of a panel survey, the willingness to subscribe to MaaS among Amsterdam and Eindhoven residents. The study revealed that only in 17% of all choices the study participants demonstrated an interest in the MaaS subscription.

By means of an online survey conducted in nationwide Switzerland, Hoerler et al. (2020) studied the openness to use MaaS for various trip purposes. Study findings suggest that almost 54% of Swiss general public were opened to use a combined mobility service for weekend leisure trips; the numbers, though, were lower, yielding 47.4%, for weekday leisure trips, and even lower for commuting, yielding 38%. Liljamo et al. (2020) studied the willingness to subscribe to MaaS among Finnish general public. The authors found that only 42% of study participants either strongly agreed or somewhat agreed they would like to have MaaS in a bundle form available to them. By surveying Australian general public, Vij et al. (2020) identified five potential MaaS user clusters, one of which, constituting just 14% of study participants, strongly intended to use MaaS for all travel needs. Another three clusters, constituting roughly 45% of the respondents, were likely to use MaaS only for some of their trips. The fifth cluster was the largest, represented by 41% of respondents who were very unlikely to become MaaS users. Moreover, as many as 63% of all survey respondents demonstrated near zero average purchasing probability across all MaaS schemes offered to them. Matyas & Kamargianni (2021) identified three clusters of potential MaaS users, of which the largest cluster, comprising 52% of study participants, appeared to be the MaaS avoiders.

2.4.2. Travel Behavioural Outcomes

2.4.2.1. Live Schemes and Pilot Operations

In November 2014, a MaaS pilot operation took place in Vienna, Austria (Smile Mobility, 2015). A MaaS application called “Smile”, offering access to combinations of public transport, shared use mobility services and active means of transport, alongside information provision, booking, payment and billing on a PAYG basis, was downloaded by circa 1,000 residents of the Austrian capital and used for their daily travel needs. Pilot evaluation via survey of around 17% of active Smile users revealed that, overall, 48% of them changed their mobility behaviour. Almost a half, or 48%, reported an increase in the use of public transport. As many as 14% of all participants increased their use of bike sharing and e-bikes. Despite significant improvements in public transport and bicycle usage, only 21% of study participants reported a decrease in the use of personal cars. Moreover, 15% of participants reported an increase in the use of carsharing and 4% reported an

increase in the use of shared e-cars. Also, while 22% of study participants stated they used taxi less, 7% reported an increase in their use of taxi.

Another example of MaaS initiative examining the potential of the concept to affect travel behaviour is the "UbiGo" study (Karlsson et al., 2020; Sochor et al., 2015; Sochor et al., 2016; Strömberg et al., 2018). UbiGo is the MaaS web interface that was piloted to 195 car-owners residing in the city of Gothenburg, Sweden. The platform offered access to combinations of bus, tram, taxi, carsharing and bike sharing in a form of monthly bundle, for which study participants paid a subscription fee starting at 1200 SEK, at the time equivalent to €135. The application allowed users to book and activate tickets and trips, and gain support from the service provider when necessary. Over the time with UbiGo, pilot participants became less positive towards private car and more positive towards alternative transportation modes. At the end of the UbiGo pilot, as many as 48% of post pilot survey participants reported more seldom use of personal cars. Abnegating personal car use, though, was the prerequisite for participation in the pilot. Yet, 4% of participants used their cars more often, while the remaining 48% saw no change. The reduction in private car use caused an increase in the use of bus and tram services, local railways and bike sharing with accordingly 50%, 18% and 23% of participants stating they used the alternatives more often. Carsharing, though faced an even greater increase in its use: as many as 57% of participants reported more frequent use of the service. Moreover, 20% of participants reported an increase in the use of taxi and 28% increased their use of car rental services.

ESP Group (2018) reports the results of piloting NaviGoGo MaaS, a personalised journey planner, with fare calculator and payment functions, offering access to combinations of rail, bus, taxi, and bike hire services, to 98 young MaaS users aged 16 to 25 in Dundee and North-East Fife, Scotland, UK. Pilot participants could pay, using their account balance, for train, taxi, and bike hire journeys, while access to the bus had to be booked separately, though the fare information was provided within the app. During the pilot operation, the young testers used the service to plan over 2000 journeys, more than 480 of which were booked and paid for using the app. Of these 480 journeys, 6% were taken by bike and 18% were taken by train. However, as many as 58% of those journeys were taken by single occupancy taxis, and the remaining 19% by multiple occupancy taxis. Only 14% of participants said they used their car less as a result of trying out NaviGoGo. Around a half of the participants to some extent agreed NaviGoGo made both public transport and shared use modes more attractive.

Whim, developed and operated by Finnish start-up MaaS Global, is a MaaS platform introduced in Helsinki in 2016. With Whim app, Helsinki residents can combine, plan, and pay, either in pay-as-you-go or monthly subscription forms, for public transport, taxi, car rental, carsharing and city bike trips. Hartikainen et al. (2019) offered a look at potential commonalities and differences in mode choices of a Whim user against average Helsinki resident. According to study's findings, MaaS consumers used public transport more than an average Helsinki resident, with public transport share for the two being 63% and 48% accordingly. Yet, the MaaS user combined taxis with Public Transport three times more often and used taxi alone 2.1 times more often than a typical Helsinki resident. Also, the number of MaaS users incorporating rental cars into their daily trips had grown over the study period.

Transport for Greater Manchester (TfGM) and Atkins/SNC- Lavalin tested, in a live pilot form, the potential of MaaS to enable a switch away from personal cars either to public transport or active transport modes, among 39 Manchester-based commuters all working in Salford (UITP, 2019). Combinations of bus, tram, carsharing, taxi, bike sharing, on-demand shared mini-bus and walking were offered to each participant in the form of personalised mobility package. After taking part in a pilot project, as many as 26% of participants became more willing to use public transport, and another 21% were more willing to use bicycles or walk for their commute. Six months following the trial, the pilot participants were interviewed to establish whether their perceptions of MaaS changed. A total of 82% of participants interviewed wanted MaaS back and one third of car owners wanted to give up their vehicle following the study.

Harrison et al. (2020a) report the results of piloting MaaS application named "Trav.ly" in West Yorkshire, UK. The app offered its users real-time multimodal journey planning combining bus, rail, walking, and cycling, informed the users of the approximate carbon footprint of each option provided, and also provided an external link to car hire. Trav.Ly was downloaded by circa 600 residents but actively used only by a maximum of around 150 residents of West Yorkshire over the course of three and a half months. The survey carried out on a limited, non-representative sample of active Trav.Ly users, also demonstrated application's potential to reduce private car use, though in less than 10% of the cases explored.

A pilot operation of corporate MaaS took place outside Stockholm, Sweden (Hesselgren et al., 2020; Zhao et al., 2020). The CMaaS mobile application was bundling three existing transport modes into one service, namely taxi, shuttle buses and commuter buses, with online booking and

real-time travel information. A new, fourth transport mode, electric bike, was also added to the system. Though being offered to 14,000 employees, the application received just 5,000 downloads in the first month, achieving around 30% interest. During the first four months the corporate MaaS app was used by on average 3,300 devices per month, or just around 25% of targeted individuals, with each user conducting only 9 sessions with the service app per month. Usage of the commuter bus and shuttle bus services, as well as taxi service showed no changes in number of passengers over the four-month trial period. The only significant change appeared due to application testers using the new electric bikes on top of other transport modes.

RideMyRoute MaaS-lite application was offered, in a pilot form, to 124 suburban residents of Brussels, Edinburgh, Ticino, and Ljubljana (Wright et al., 2020). The application is referred to as MaaS-lite as it only offered access to ride-sharing services that matched public transport schedules. By running a post-pilot survey, the authors discovered that only a third of all participants intended to continue using the app. Moreover, just over a fifth of the of RideMyRoute app testers in four European cities stated they would be likely to drive less, while between 40% and 50% of participating individuals were likely to ride-share more as a result of using the App. The survey of 1,072 members of general public in Brussels, Edinburgh, Ticino, Ljubljana, but also Zagreb, taking place before the pilot operation (Wright et al., 2018; 2020), also looked at the intention to use RideMyRoute service as well as hypothetical travel behavioural changes induced by the app. Less than a half, that is between 32.3% and 42.8% of respondents in five cities intended to use the service on offer. On average, only 14.5% of respondents agreed they would be more likely to ride-share if the service was available, and only 11.2% agreed they would be more likely to use public transport.

Another pilot study (Storme et al., 2020) took place in Ghent, Belgium with car owners using a MaaS application for two and a half months. Study participants were given access, via a smartphone app called “Touring” to MaaS packages offering access to combinations of bus, trams and train, public and peer-to-peer carsharing, car rentals, taxi, bike rental, and round-trip bike sharing. The package value for each participant was determined by looking at the estimated value of the car they owned and the frequency of them using that car for commute, and could be either €150, €250, or €350, which the participants did not have to pay for. The participants, though, were asked to minimise the use of their personal cars to the largest possible extent, with it being penalised at €0.50/km and deducted from the value of their MaaS bundle. Moreover, cash prizes of up to €500 were offered to five pilot participants who used their personal cars the least among

others. Despite the strict rules and reasonable incentives, pilot participants demonstrated rather unsustainable mode choices: a third of all MaaS budget offered to participants was spent on the use of personal cars whilst another third was used to access carsharing services. Over the study period participants purchased a total of 545 bus and tram tickets and 162 train tickets, which accounted for only circa four public transport trips per participant per month.

A MaaS application "Tripi" offering access to combinations of public transport, taxi, ride-hailing, carsharing and car rental services, both in PAYG and monthly bundle forms with some discounts for public transport, taxi, and ride-hailing, was piloted to 93 residents of Sydney, Australia (Hensher et al., 2021; Ho et al., 2021). The pilot results suggest that the increase in the likelihood of choosing the MaaS bundle over PAYG option reduces the miles travelled by personal car, though not explicitly focusing on what transport modes in the bundle substitute for personal car travel (Hensher et al., 2021).

2.4.2.2. Surveys and Stated Preference Experiments

Using a stated preference experiment, Ho et al. (2020) studied the potential impact of MaaS on public transport usage in Sydney and Tyneside. According to study's findings, over a half of participants in Tyneside would use more public transport when equipped with MaaS; as many as 25%, though, stated MaaS would have no impact on their public transport usage patterns, while 15% of respondents were willing to replace public transport trips with taxis and another 5% with carsharing. Only about 40% of participants in Sydney agreed they would use more public transport when equipped with MaaS. Almost an equal number of Sydney based respondents stated MaaS would have no impact on the amount of public transport trips they make. Circa 13% sated they would replace some of their public transport trips with taxis, and another 7% were willing to replace public transport trips with carsharing.

A recent study by Kamargianni et al. (2018) tested, via a digital London Mobility Survey (LMS), attitudes towards car ownership, carsharing and the concept of MaaS, and measured the potential of MaaS to induce modal shift among Greater London residents. According to the survey results, only 40% of study participants confirmed their intentions to try new transport modes with MaaS. Only 33% of car-owning respondents agreed MaaS would help them lower their dependence on a private car. Even offered unlimited access to carsharing, as many as 61% of car-owning respondents were not willing to sell their cars. Only 36% of non-car-owners confirmed they would

delay buying a car if MaaS was available to them. While 28% of survey respondents intended to substitute their public transport trips with more public transport and 23% assumed there would be no change to public transport use if MaaS became available, as many as 22% were willing to substitute public transport trips with taxi when equipped with MaaS. Integrated within MaaS carsharing was an attractive public transport trips' replacement for another 12% of respondents. When it came to car trips substitution, 35% of all survey respondents stated they would use public transport instead and another 34% stated they would walk or cycle. As many as 13% of respondents, however, refused substituting their car trips even if equipped with MaaS, while 7% wanted to use carsharing, and another 11% wanted to use taxi instead. Guidon et al. (2020), on the other hand, by running a survey in Zurich, Switzerland, discovered that the average consumer did not wish to purchase a monthly taxi subscription, neither in a bundle nor as a stand-alone service, when quipped with MaaS, though willing to pay for combinations of PT and carsharing. Reck & Axhausen (2020), by conducting an experiment in the city of Copenhagen, Denmark, found that current car users, representing circa 23% of the studied sample, are to switch to either public transport (circa 17% of cases explored), carsharing (circa 3.3% of cases explored), or walking (circa 2.7% of cases explored) when equipped with MaaS.

The results of survey conducted by Vij et al. (2020) suggested that the Australian general public were sceptical about the ability of MaaS to impact their decisions related to car ownership. So, the respondents majorly disagreed MaaS would help them depend on car less. To even larger degree the respondents were unlikely to delay buying a car or to not buy a car at all be MaaS available. Moreover, they also disagreed that their households would need fewer cars if MaaS was available on the market. Liljamo et al. (2021), on the other hand, by surveying Finland's general public, discovered that as many as 39% of respondents would not want or need to own a car if only public transport connections were sufficient; the number, though, increased to 58% when the availability of MaaS was hypothesised.

2.4.3. Drawing Conclusions from the Literature

The above evidence suggests that at present the potential acceptance of a service like MaaS by transport users remains low, and the potential MaaS induced mobility consumption and modal choices of these, often narrow, groups of adopters, e.g., just 17% in the study by Caiati et al. (2020), may not be entirely sustainable. Whilst a large proportion of the identified studies report the ability of MaaS to induce modal shift away from personal car to public transport, the extent of the shift

varies significantly, and it remains unclear whether the increased use of these modes implies substitution of a large proportion of car trips with public transport or, for an instance, just an occasional public transport trip in place of driving. Yet, people who have a clear preference for personal cars are unlikely to change their driving habits or refrain from car ownership when faced with MaaS services, as in the case described by Storme et al. (2019). Moreover, people who prefer cars over alternative means of transport may not necessarily own them in the MaaS era yet continue to actively utilise them for their everyday travel needs accessing on a more frequent basis car-based shared use mobility modes, as in the case of UbiGo. It is also likely that a certain proportion of regular active travellers (e.g., cyclists) and public transport users, when adopting MaaS, will fully substitute their current trips with car-based shared use mobility. Increased use of such services can potentially cause a rise in the number of cars on the roads and, thus, worsen road congestion, increase air pollution, and also result in a movement away from healthier, more active travel choices, this way compromising overall sustainability (Hensher, 2017; Pangbourne et al., 2020). Another aspect that is not explicitly covered by the identified body of the literature is the fact that MaaS may generate new trips (Jittrapirom et al., 2018), putting even more pressure on the already busy transport networks. Therefore, this study makes its purpose to generate insights that will help resolve this travel behavioural controversy.

Even though the adoption of MaaS has recently become the subject of much attention, as evident from the number of identified herein studies, none of these studies focus exclusively on possible unsustainable travel behavioural outcomes that may follow MaaS adoption. Moreover, most of the reported potential acceptance and modal shift levels do not agree, which means, based on these findings, no clear conclusions can be made regarding the likelihood of unsustainable travel behaviours occurring upon MaaS introduction. Furthermore, it is not clear what needs to be done to ensure MaaS is consumed appropriately, without compromising the overall sustainability. It is widely recognised that attempts to address unsustainable travel behaviour involve a detailed understanding of the reasons for choosing one mode of transport over another (Anable, 2005). Therefore, it is suggested that a survey focusing on the likelihood of a variety of unsustainable travel behaviours occurring when shifting to MaaS paradigm, but also the drivers behind these unsustainable choices, would be much more revealing and help inform policy and governance to ensure MaaS becomes an effective tool for enabling sustainable travel behaviour.

2.5. Factors affecting MaaS Acceptance and Travel Behavioural Response

For this study to achieve scientific rigour in defining the factors that affect and reflect MaaS acceptance and travel behavioural response a theoretical framework must be defined that will determine the direction of further investigation. According to the literature, travel behavioural decision-making process is a complex phenomenon that integrates various components (Anable, 2005), the precise origins of which are difficult to pinpoint (Biehl & Stathopoulos, 2020). Researchers in general believe travel behaviour to be influenced either by socio-demographic individual characteristics (e.g. Klein et al., 2018; Polzin et al., 2014), including urban form and built environment (e.g. Guan et al., 2019; Mouratidis et al., 2019), or attitudinal variables (e.g. Bamberg & Schmidt, 2003; Donald et al., 2014; Elliot et al., 2007; Moons & De Pelsmacker, 2015). Much empirical evidence also supports the notion that past behaviour, often measured through frequency of its performance, is a strong predictor of future behaviour (Ajzen, 2011). Through a comprehensive review of the literature, similar attributes were found to have an influence on mode choice also with MaaS.

2.5.1. Socio-Demographics

Impact of socio-demographics on travel behaviour has been investigated by a number of studies and have been found to have a significant relationship with travel behavioural decisions (Veterník & Gogola, 2017). The effects of age, gender, household composition, employments status, level of education, household income, and the type of residential locations have all, in various combinations, been studied in the MaaS literature, with varying effects on MaaS acceptance and MaaS induced travel behaviour.

2.5.1.1. Age

Age was established as a demographic factor with an influence on MaaS acceptance and induced travel behaviour by numerous studies. So, Alonso-Gonzalez et al. (2017) discovered that young adults were most prone to include demand responsive transport in their mobility choices, and thus were more prone to MaaS adoption, while individuals aged 50 to 64 were the least likely to do the latter. Ho et al. (2018) found age to have an impact on individuals' decision to subscribe to MaaS. Matyas & Kamargianni (2018) discovered that individuals aged 65 and over were less likely to choose bike sharing and taxi as transport options for their MaaS bundles as opposed to younger individuals. Alonso-Gonzalez et al. (2020) found a tendency among individuals in two user clusters

with the most favourable attitude towards mobility integration and MaaS to be young. Caiati et al. (2020) discovered that people aged 18 to 35 were more inclined to subscribe to MaaS than those aged 51 and over. The authors also found out that people older than 50 preferred to have PT in their MaaS bundles, while younger people, 25 to 35 years old especially, were less likely to include PT. The 25 to 35-year-olds were, though, more likely to choose e-bike sharing and e-carsharing. Feneri et al. (2020) suggested that younger age groups were more eager to choose a MaaS based travel than older age groups. Hoerler et al. (2020) found that people aged 35 to 54 were more opened to adopt MaaS for weekend leisure trips than any other age groups. Jang et al. (2020) found the preference for public transport within MaaS bundles to be stronger for individuals aged 65 and over, and lower for individuals younger than 25 years. Polydoropoulou et al. (2020a; 2020b) suggested that a strong predisposition to adopt MaaS plans was determined by younger age. Schikofsky et al. (2020) identified that behavioural intention to adopt MaaS of individuals aged 18 to 39 was significantly stronger than of those aged 40 to 60. Vij et al. (2020) found that younger individuals, majorly under the age of 30, had the greatest likelihood of purchasing MaaS. Wright et al. (2020) discovered that the intention to use MaaS-like RideMyRoute app decreased with increasing age. Ye et al. (2020) did not find a direct influence of age on intention to adopt MaaS, though confirmed age had an effect on individual MaaS attitudes. Age was also found to be highly relevant by Zijlstra et al. (2020): so, individuals aged 55 and older were found to have a very low probability of MaaS adoption, while individuals aged 18 to 39 were very highly inclined to adopt the tool. Ho et al. (2021) found participant age to have an influence on the probability of choosing PAYG MaaS, with older individuals having a lower probability of choosing the option compared to young participants. Matyas & Kamargianni (2021) likewise found age to be related to individual likeliness to purchase MaaS packages, with older individuals being the most likely to avoid the purchase.

2.5.1.2. Gender

Some studies have also identified gender as an influencing factor on MaaS uptake and adoption. The cluster with the highest likelihood of using MaaS identified by Fioreze et al. (2019) was over 56% female, while the cluster with low likelihood of MaaS adoption was overrepresented by males. Caiati et al. (2020) also established that females were more likely to subscribe to MaaS than males, though the difference between the two likelihoods was relatively small. The authors also discovered that males were more likely to choose e-carsharing for their MaaS bundles, while females preferred ride-sharing. Polydoropoulou et al. (2020b) likewise identified that being female

was yet another characteristic of individuals with the strongest predisposition to adopt MaaS plans. Vij et al. (2020), though, found that 55% of individuals most likely to purchase MaaS were male. Males were also found to show stronger preferences for public transport within MaaS bundles in the study by Jang et al. (2020). Wright et al. (2018), however, found no real difference in MaaS use intentions among male and female individuals. Although again not finding the direct influence of gender on intention to adopt MaaS, Ye et al. (2020) found gender to influence MaaS related attitudes. Ho et al. (2021) established that male individuals were more likely to choose PAYG MaaS option than female participants.

2.5.1.3. Household Composition

Household composition was also found to play a role in MaaS adoption. Ho et al. (2020) suggested that households with two or more children were significantly less likely to subscribe to MaaS than households with up to one child. Alonso-Gonzalez et al. (2020) found a tendency to have no children in the two clusters of individuals with the most favourable MaaS attitude. Caiati et al. (2020), on the other hand, discovered that those more likely to subscribe to MaaS were individuals living with their parents, and single people or couples with children. Vij et al. (2020) found 42% of individuals with the strongest likelihood of purchasing MaaS to have children at home. Similar was established by Zijlstra et al. (2020) suggesting that couples with children living at home had higher potential to adopt MaaS, though the effect was small.

2.5.1.4. Employment Status

Some studies established an effect of employment status on MaaS uptake and use. Alonso-Gonzalez et al. (2017), for example, suggested that full time workers and self-employed individuals were more likely to have demand responsive transport in their modal portfolio, thus showing MaaS prone behaviour. Keller at al. (2018), found that housewives and househusbands had a higher intention to adopt IMM platforms compared to other job groups. Fioreze et al. (2019) established that over 77% of individuals with a low likelihood of using MaaS were employed. According to Caiati et al. (2020), though, it is employed, retired people and students who were more likely to join MaaS schemes, while unemployed and those looking for a job had a negative subscription inclination. The authors also suggested that students were far more likely to include PT in their MaaS bundles, while unemployed and job seekers demonstrated a clear preference for inclusion of taxi, and retired people demonstrated a preference for on-demand bus. The findings of Feneri et al. (2020)

suggested that job seekers were less likely to stick to their old travel habits but were also less likely to choose public transport when travelling with MaaS. Vij et al. (2020) discovered that 73% of individuals with the greatest likelihood of purchasing MaaS were employed. Zijlstra et al. (2020) found the strongest intention to adopt MaaS among students, while retired individuals were the least likely to adopt the tool.

2.5.1.5. Level of Education

The level of education may also have a role to play in MaaS adoption. For an instance, Alonso-Gonzalez et al. (2017) found a connection between the inclusion of demand responsive transport in the mode choices and level of education, with more educated individuals being more likely to do the latter and, consequently, more likely to engage with the MaaS bundles. Fioreze et al. (2019) observed a significant association between education level and the likelihood of using MaaS, but the authors took this association with caution as the sample was not representative of the population investigated. Alonso-Gonzalez et al. (2020) found individuals in the two clusters favouring MaaS to be highly educated. Caiati et al. (2020) discovered that individuals with a middle level of education saw the most value in MaaS subscription, while those with high education saw the least value in the latter, but were also more likely to include ride-sharing in their MaaS bundles. Hoerler et al. (2020) discovered that higher level of education had a positive influence on individual openness to use MaaS for weekday and weekend leisure trips. Polydoropoulou et al. (2020b) indicated that holders of at least a bachelor's degree were more likely to be MaaS adopters. As established by Vij et al. (2020), half of individuals with the greatest likelihood to purchase MaaS were college educated. Zijlstra et al. (2020) and Matyas & Kamargianni (2021) also confirmed a strong effect of higher education level on the intention to adopt MaaS.

2.5.1.6. Household Income

A number of studies discuss the role of household income in the adoption of MaaS. Matyas & Kamargianni (2018) suggest that transport users with lower household incomes prefer to have bus passes more than those with higher household incomes, thus meaning lower household income groups are more likely to rely on public transport when using MaaS. Specifying five monthly income groups in their study, Caiati et al. (2020) identified that individuals with lower monthly incomes under €1250, and those earning €1876 to €3125 were less likely to adopt MaaS; on the other hand, individuals earning between €1251 and €1875, and those with incomes above €3125

demonstrated a stronger MaaS use intention. Low-income respondents (< €625), together with those having average income (€1251–€1875), according to findings, were also more likely to include car rental in their MaaS bundles. Jang et al. (2020) found low-income individuals to be more likely to include public transport but also E-bikes, E-carsharing and ride-sharing within their MaaS bundles, whilst high-income individuals demonstrated a clear preference for taxi. Similar to the effect of age, increasing income resulted in decrease in the intention to adopt RideMyRoute app in study by Wright et al. (2020). An identical effect of income on intention to use MaaS was found also by Zijlstra et al. (2020) and Matyas & Kamargianni (2021): the intention to adopt MaaS became stronger with higher monthly incomes.

2.5.1.7. Type of Residential Location

The majority of MaaS investigations focus on urban areas around the globe. Yet, a number of studies that looked at general population samples identify the role of residential location in the MaaS acceptance and travel behaviour determination. So, people living in denser environments were found to have higher potential to adopt MaaS in the study by Zijlstra et al. (2020). Urbanisation level characteristics improved the model in Alonso-Gonzalez et al. (2020). Hoerler et al. (2020), though, found no significant impact of residential location, or place of residence as stated in the study, on individual openness to use MaaS.

2.5.2. General Attitudes

Although socio-demographics play an important role in interpreting travel behaviour, general attitudes and perceptions bear explanatory power over and above socio-demographic characteristics (Anable, 2005; Haustein & Hunecke, 2013; Hunecke et al., 2010). Attitudes were also the first psychological constructs to be utilised in travel behaviour research (Gärling et al., 1998). These psychological factors also play a crucial role in MaaS acceptance (Schikofsky et al., 2020) and may be important in prompting an interest in becoming MaaS customers (Karlsson et al., 2020).

2.5.2.1. Technology Attitudes

According to the Diffusion of Innovations theory (Rogers, 2003) one of the main characteristics of early adopters of novel technology is innovativeness, or in other words curiosity about new technology. Similar applies in the context of MaaS as discovered by a number of studies. One of

the first MaaS pilots, the UbiGo MaaS, has generated evidence of curiosity about innovative technological solutions to be the main driver behind the intention to try the service out (Sochor et al., 2015; Karlsson et al., 2020). Individual innovativeness, as also discovered by Keller et al. (2018), had a positive association with interest in using MaaS like platforms. Being enthusiastic about innovative mobility services, such as Uber, BlaBlaCar and others, was established as a driver of MaaS acceptance by Fioreze et al. (2019). The level of individual innovativeness, which implied being curios about innovative solutions, taking the lead in trying new technologies, and finding the trying out of new services interesting, was found to be the strongest driver of MaaS acceptance by Ye et al. (2020). Innovativeness, expressed as the desire to try and purchase new services first, being optimistic about technology, open to new ways of travel, and having opinion leadership among peers, was found to be relevant for the MaaS adoption by Zijlstra et al. (2020).

Some studies also discuss the role of cyber-security perceptions and issues as important in the MaaS adoption. According to Sochor et al. (2015), it was a vital expectation of the UbiGo testers for MaaS to be secure in terms of protecting personal information or preventing unrestricted access. Keller et al. (2018) found perceived technology security to be positively associated with the intention to use MaaS-Like products. In the work by Gairal Casadó et al. (2020) the tracking of movements was raised as a cyber-security issue preventing the MaaS acceptance. Not only movement tracking concerns but also the issues with sharing credit card information were expressed as barriers to MaaS acceptance by focus group participants in the study by Polydoropoulou et al. (2020a). Schikofsky et al. (2020), on the other hand, found no support for the assumption that the MaaS adoption decision is influenced by cyber-security concerns, such as movements tracking, etc. Similarly, Caiati et al. (2020) discovered that potential MaaS users do not mind about privacy issues and are even willing to accept the access of MaaS application to GPS. Other studies suggest that concerns with MaaS enabling technology, such as smartphones, may also influence the MaaS adoption decision. For example, Polydoropoulou et al. (2020a) discuss the need for a backup option as reliance on a smartphone when travelling with MaaS puts an individual at risk of running out of battery, losing connection, or forgetting/losing the device itself and eventually not getting the service. On top of the above, the issue of running out of smartphone credit was raised in the study by Gairal Casadó et al. (2020).

Derived from the psychology-based theory of reasoned action (TRA) and theory of planned behaviour (TPB), Technology Acceptance Model (TAM) (Davis, 1989) was developed specifically for modelling users' acceptance of new technologies. The model suggests that the perceived

usefulness of technology and perceived ease of use directly determine the intention to use the technology under question. Mola et al. (2020) tested the ability of TAM variables to explain the intention to use MaaS. The authors found the perceived usefulness to influence the decision to use MaaS; the effect of perceived ease of use, however, was mediated by perceived usefulness. Schikofsky et al. (2020) established that perceived usefulness of MaaS, associated with perceived efficiency and performance, as well as rational, functional, and economic benefit of using MaaS, had a strong influence on the intention to use the service; however, the ease of use, associated with easy access to mobility and easy operation of the MaaS app, appeared not to be a driver behind the use decision. On the contrary, Sochor et al. (2015) found the ease of using the MaaS app to be one of the major expectations of the service among potential MaaS users. Being comfortable with the use of smartphones and apps was also found to have an influence on MaaS acceptance by Ye et al. (2020) and Zijlstra et al. (2020). Karlsson et al. (2020) mentioned how individuals who perceived the use of MaaS requiring too much effort decided not to partake in the MaaS pilot. As for other psychological theories used in the MaaS research, Keller et al. (2018) studied the derived from Diffusion of Innovations theory (Rogers, 2003) variables of advantage and personal compatibility, in a way similar to TAM's perceived usefulness, and found them to be positively associated with the intention to adopt IMM platforms. The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) was tested in the context of MaaS by Ye et al. (2020). Performance expectancy, analogous to perceived usefulness in TAM and concerned with time, cost, convenience, and accessibility benefit of MaaS, alongside effort expectancy, analogous to ease of use in TAM and concerned with ease of understanding and learning to use the service, were found to have a significant impact on intention to use MaaS.

2.5.2.2. Social Norms

The UTAUT model is composed of two additional variables, namely facilitating condition, derived from TPB construct of perceived behavioural control (PBC) and associated with physical and mental tools necessary to use the technology, and social influence, derived from TPB construct of subjective norm (Venkatesh et al., 2003). While Ye et al. (2020) found no real effect of facilitation condition on MaaS adoption, social influence, comprising of positive media evaluation of MaaS, praise from others and observability of use among peers, was also a strong driver of MaaS adoption. The role of social influences in MaaS adoption was also recognised by Keller et al. (2018): the authors discovered that derived from DoI observability of use in the personal environment was positively associated with the intention to adopt IMM platforms. Alonso-Gonzalez et al. (2020)

found that the perception of being liked by others only when using owned mode of transport, such as own car or bike, was a barrier to MaaS adoption. Biehl & Stathopoulos (2020) found the neighbourhood norms, associated with peers in the neighbourhood embracing innovation in mobility services and having active transport use as a priority, to be crucial in boosting active mobility values in the MaaS era. Caiati et al. (2020) revealed significant effects of general public reviews of the MaaS service and the hypothetical use of MaaS among different members of potential user's social network on the subscription intention. Schikofsky et al. (2020) found a positive feeling of a shared identity and belonging to the group of like-minded MaaS users to influence MaaS adoption. Hoerler et al. (2020), though, found no significant effect of social influences, or peer effects, on openness to using MaaS.

2.5.2.3. Personal Car Attitudes

As noted in previously, overcoming the dependence of transport users on personal cars is the ultimate goal of a MaaS system. Thus, it is not surprising that the attitudes towards personal cars were found to influence MaaS acceptance and use by a number of MaaS related studies. The attitudes towards personal car underpin MaaS uptake according to the findings of Sjöman et al. (2020). Fioreze et al. (2019) suggest that the willingness to use alternative to car travel modes has a positive influence on the MaaS adoption. Similar was established by Sochor et al. (2015; 2016) and Hoerler et al. (2018). Perceiving the car as more convenient than any other travel option was found to be a barrier to MaaS adoption by Ho et al. (2018). Those who saw personal car as a symbol of their status and identity had a preference to own one and, thus, were reluctant to rely on a tool like MaaS for their travel needs, as suggested by Gairal Casadó et al. (2020) and Matyas (2020). Perceiving MaaS as less convenient than personal car was the reason not to subscribe to MaaS for almost 31% of respondents in the study by Matyas & Kamargianni (2021).

2.5.2.4. Attitudes towards Alternative Transport

MaaS integrates a variety of transport modes and mobility services into a single service offering. The attitudes towards these different MaaS components were found to influence individual adoption decision. A number of studies talk about the importance of attitudes towards transport modes integrated within MaaS. Matyas (2020), for example, discussed how transport users split the offered within MaaS modes into essential, considered, and excluded, with the latter preventing MaaS bundle adoption. Positive attitudes towards multimodal travel and perceived ease of

transferring between modes during journey were found to influence MaaS acceptance by Polydoropoulou et al. (2020b). The attitudes towards public transport, and the safety concerns around its use specifically, were also found to play a role in the MaaS adoption by Gairal Casadó et al. (2020): according to the study, previous encounters with violence or criminal behaviours on public transport modes made people hesitant about relying on a service like MaaS for all their travel. Hence the need for crowding and urban security information, expressed by participants in the study by Lopez-Carreiro et al. (2020). Schikofsky et al. (2020), however, found no evidence for the latter issue to influence MaaS adoption intentions. A number of studies have also identified the attitudes towards shared use mobility to influence MaaS adoption. So, Fioreze et al. (2019) and talked about the attitudes towards sharing transport means as a determinant of MaaS use. Matyas (2020) found the perceptions of complexity of using shared use mobility services to significantly discourage individuals from using them when equipped with MaaS. Perceiving shared use mobility modes as safer, more flexible, more reliable and giving more freedom than public transport encouraged individual intentions to use those modes when travelling with MaaS, according to Alonso-Gonzalez et al. (2020). As for active modes of travel, some studies (Gairal Casadó et al., 2020; Matyas, 2020) discuss how they induce concerns around personal health, or "crippling anxiety" – the reasons those are unlikely to be used in the MaaS era.

2.5.2.5. Attitudes towards MaaS Components

On top of attitudes towards integrated within MaaS transport modes, the attitudes towards MaaS as a whole, and its digital features, were found to play a role in its adoption. Fioreze et al. (2019) suggest that the reason behind reluctance to accept and use MaaS for travel is transport users not perceiving MaaS as a value-adding service. Features such as integration (Alonso-Gonzalez et al., 2020), route optimisation (Lopez-Carreiro et al., 2020), but also provision of real time reliable solutions, flexibility, wide coverage, personalisation, and tourism support, as in Polydoropoulou et al. (2020a), were found to add value to MaaS and increase the interest in using the service for travel; being a part of a wider social network of transport users was, though, not of interest. In addition to the service features that drive interest in MaaS, it is MaaS-promoting policy announcements that may drive transport users towards the concept (Hoerler et al., 2020). What was also found important is the fitness of MaaS to specific transport related user needs (Alonso-Gonzalez et al., 2020; Karlsson et al., 2020). The acceptance of MaaS was also found to be driven by psychological needs, such as anticipated autonomy and competence advantage, and hedonic

motivations, such as fun, enjoyment, and pleasure associated with the use of MaaS (Schikofsky et al., 2020).

2.5.2.6. Environmental Concerns

According to a number of studies (Hunecke et al., 2001; Steg & Vlek, 2009; Wall et al., 2007) individual moral concerns, especially with regards to the environment, play an important role in determining sustainable mode choices. Environmental concerns were likewise established as the determinants of MaaS adoption. So, Sochor et al. (2015) discovered that pro-environmental reasons contributed to the willingness to try living without a personal car through testing MaaS. Considerations of reducing car use due to its impact on the environment were established as the drivers of MaaS uptake also by Fioreze et al. (2019). Alonso-Gonzalez et al. (2020) found that the willingness to use public transport when travelling with MaaS was determined by individual desire to preserve the environment. Hoerler et al. (2020) found pro-environmental attitudes to positively influence openness to use MaaS for weekend leisure trips. There is, however, a body of research suggesting that environmental reasons are of little importance to the uptake of MaaS. In the study by Gairal Casadó et al. (2020), for an instance, the impact of cars on the environment did not seem to influence the decision to use MaaS. Environmental concerns were mentioned by participants of the study by Karlsson et al. (2020) but appeared as though they were not a decisive factor in the decision to try out MaaS. Whilst being interested in being provided environmental impact information on their travel, participants of the study by Lopez-Carreiro et al. (2020) considered this information irrelevant for travel mode choice, at least in the short term. Environmental attitudes, while not being completely irrelevant, had subordinated relevance to MaaS adoption intention also in the study by Schikofsky et al. (2020).

2.5.2.7. Cost Considerations

Last but not least, the potential cost of MaaS also has a role to play in the MaaS adoption. As discovered by Sochor et al. (2015; 2016) and Hoerler et al. (2020) potential MaaS users expect the service to either be cheaper than or match their current cost of travel. Fioreze et al. (2019) found that even having longer travel times would not discourage individuals from adopting MaaS as long as using the service worked out cheaper than what they did before. Alonso-Gonzalez et al. (2020) suggest that individuals would actually be ready to pay extra for the service like MaaS in exchange for more predictable journey times as well as precise and reliable travel information. Karlsson et

al. (2020), on the other hand, states that the expectations of MaaS being more expensive than the current way of travelling was the barrier to trying out MaaS for a number of participants, which lead them to decline participation in the pilot. Jang et al. (2020) suggest that the decision to use more or less of non-environmentally friendly modes, such as taxi and car rental, when subscribing to MaaS bundle depends on the fee the user has to pay for that bundle. Feneri et al. (2020) suggest that it is not a monthly fee as a stand-alone, but a combination of monthly fee and discounts within bundles that influence MaaS bundle compositions transport users are to choose. Discounts for shared use mobility services and off-peak travel with MaaS were also desired by participants in the study by Polydoropoulou et al. (2020a). Ho et al. (2018; 2020), Liljamo et al. (2020), and Mulley et al. (2020), who studied individual willingness to pay for MaaS, found the latter to be lower than the current cost of travel meaning individuals wanted to save when travelling with MaaS. Ho et al. (2021) likewise suggest that financial savings attract interest in MaaS and the uptake of MaaS in a bundle form.

2.5.3. Past Behaviour

Past behaviour, often equated with habit, is known to be a good predictor of future actions (Fishbein & Ajzen, 2010). Once performed behaviour delivers the desired outcome, through repetition, it becomes habitual (Hoffman et al., 2017), decreasing the level of individual consciousness when responding to behaviour specific stimulus cues (Triandis, 1980). Many studies have shown that travel is a habitual behaviour driven by pure repetition (Matyas & Kamargianni, 2018), especially in the case of mode choice (Kenyon & Lyons, 2003). Habits and existing travel practices were also found to potentially discourage overall MaaS adoption (Karlsson et al., 2020) and determine the choice of transport configurations within MaaS bundles (Matyas, 2020; Reck & Axhausen, 2020). It is also known that future MaaS consumers classify the use of MaaS based on similarities with their travel related habits and typical mobility patterns, such as previous use of personal car or bike-sharing (Schikofsky et al. 2020).

2.5.3.1. Car Ownership

Although car ownership is generally studied as a demographic feature, here we refer to it as behaviour since reducing car ownership is among the most desired behavioural outcomes, but also strong determinants, of MaaS adoption. Fioreze et al. (2019), for example, found low rate of car ownership per household to be associated with high likelihood of using MaaS. Alonso-Gonzalez et

al. (2020) found car owners to have a tendency not to adopt MaaS. Caiati et al. (2020) established that individuals having access to one car were actually more likely to subscribe to MaaS; having access to more than one car, though, negatively affected the subscription decision. People having access to just one car in their household were also more inclined to choose car rental for their bundle configuration. Ye et al. (2020) found car ownership to influence MaaS related attitudes. Ho et al. (2021) found that households with one car and with more than two cars, compared to non-car-owning households, both had lower probability of choosing PAYG MaaS rather than a bundle. Zijlstra et al. (2020), however, established no real effect of car ownership on MaaS adoption.

2.5.3.2. Car Use

Not just car ownership but also personal car use was found to have an effect on both MaaS uptake and modal shift with MaaS. So, according to findings of Ho et al. (2018), individuals never using a car and those using a car five to seven days a week were less likely than average to subscribe to MaaS. Individuals using a car one to two days a week and those using a car three to four days a week were the most likely MaaS adopters. Fioreze et al. (2019) established that individuals who almost never travelled by car were more likely to use MaaS than individuals who used the car on a daily basis. Alonso-González et al. (2020) confirmed that unimodal car travellers tended to be reluctant to adopt MaaS. Biehl & Stathopoulos (2020) discovered that those individuals who frequently drove alone for various purposes were the least likely to alter their travel behaviour with MaaS. The results of Caiati et al. (2020) suggest that individuals tend to be much less willing to subscribe to MaaS when in their daily trips they mainly travel by car as a driver. Ho et al. (2020) discovered that the interest in MaaS decreased with increasing car use. Hoerler et al. (2020) found that individuals who relied on car for their leisure trips were not opened to using MaaS for the latter. Zijlstra et al. (2020), though, found no clear effect of car use on interest in MaaS, while Feneri et al. (2020) found that car drivers were more likely to shift away from their current modes in presence of MaaS. Individuals travelling by car, but as passengers, were found to be more willing to subscribe to MaaS (Caiati et al., 2020) and also more likely to alter transport mode choices (Feneri et al., 2020) than other transport users.

2.5.3.3. Use of Public Transport

As for the use of public transport, Matyas & Kamargianni (2018) discovered that individuals currently holding public transport travel cards were more likely to prefer the same for their MaaS

bundles. Fioreze et al. (2019) established frequent use of train to be associated with high likelihood of using MaaS. Alonso-Gonzalez et al. (2020) found that the intention to use MaaS was associated with the possession of public transport smartcards. Moreover, individuals who never used public transport were found to be reluctant to adopt MaaS, while those using public transport weekly intended to adopt the tool. Similarly, Biehl & Stathopoulos (2020) established that those, who frequently used public transport were the most likely MaaS adopters. Caiati et al. (2020) found people who travelled by public transport or train to be more willing to subscribe to MaaS. Public Transport users also tended to choose the mode for their bundle configuration but were less likely to pick on-demand bus. Ho et al. (2020) established that the likelihood of subscribing to MaaS increased with increasing use of public transport. Interestingly, the opposite was observed for Sydney (Ho et al., 2018). Matyas (2020) found that, regardless of whether potential MaaS users were car drivers or not, they considered public transport an essential part of their travel patterns and would only buy MaaS plans that included the latter. Zijlstra et al. (2020) established that frequent public transport users were likely to be among the early adopters of MaaS.Similar was suggested by Matyas & Kamargianni (2021). Hoerler et al. (2020), however found that individuals who used public transport for commuting more than a private car thought there was no need for a service like MaaS, for commute specifically.

2.5.3.4. Use of Publicly Shared Cars

Previous experience with publicly shared cars was also found to play a part in MaaS adoption. According to findings of Matyas & Kamargianni (2018), frequent use of taxi was a driver behind the inclusion of taxi in MaaS bundle. Alonso-Gonzalez et al. (2020) found that the intention to use MaaS was associated with previous use of services like Uber. Caiati et al. (2020) found carsharing membership to positively influence the preference for MaaS, while absence of experience with ride-sharing services made individuals less inclined to include it in MaaS bundle. Ho et al. (2020) found that MaaS plans were very attractive to those who regularly used taxi and Uber; though, it is important to note that hypothetical discounts for these services were offered in the experiment. Similarly, Matyas & Kamargianni (2021) discovered that enthusiasm to purchase MaaS packages was associated with more frequent use of taxi services.

2.5.3.5. Use of Bikes and Walking

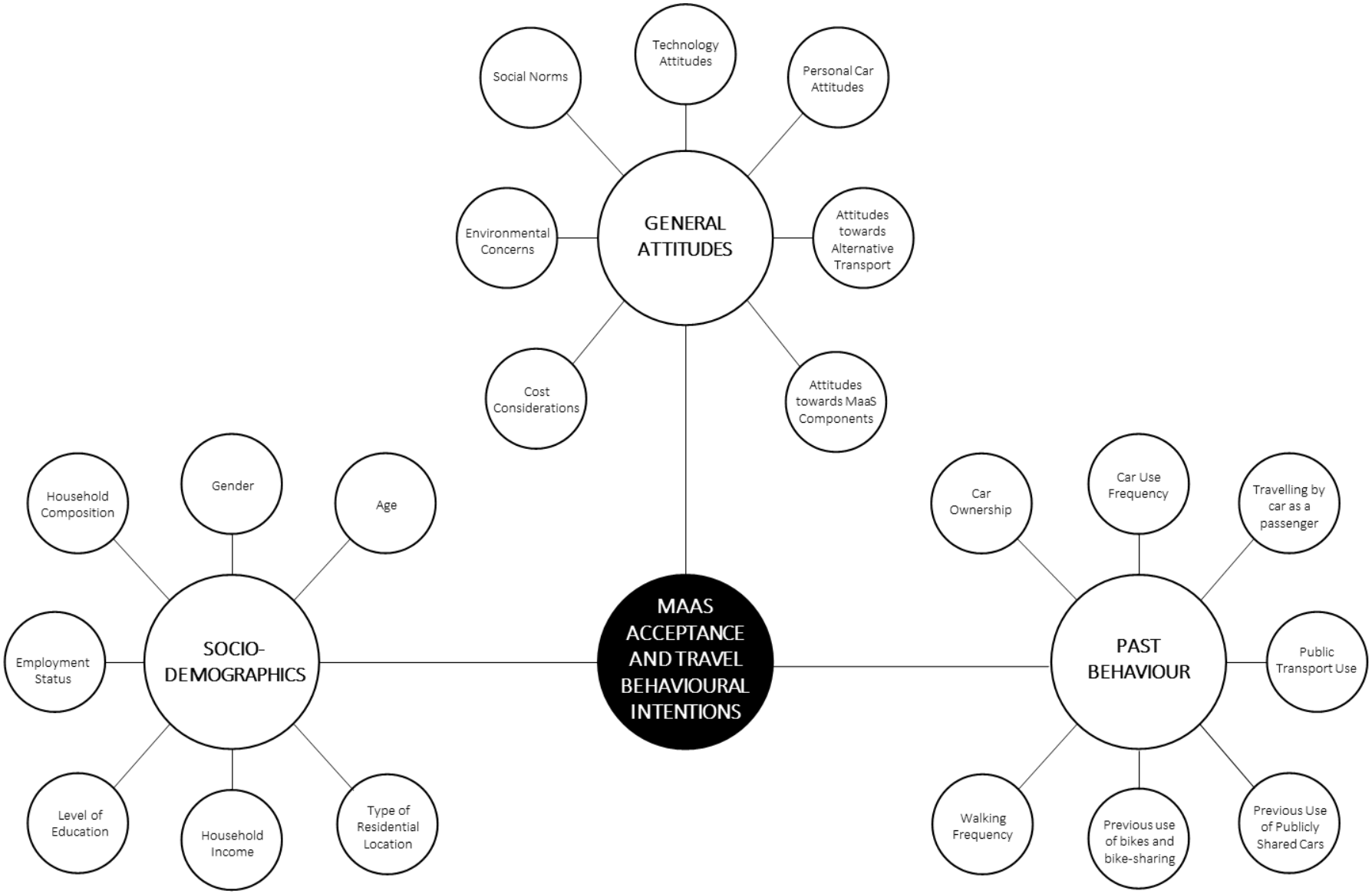
Matyas & Kamargianni (2018) found bicycle ownership and previous experience with using bike-sharing schemes to have a positive effect on the decision to subscribe to MaaS. Alonso-Gonzalez et al. (2020) found that the intention to use MaaS was associated with frequent use of bike-sharing. Biehl & Stathopoulos (2020) discovered that those who frequently used bicycles and walked for the most part, were the most likely MaaS adopters. Feneri et al. (2020) found that those who walked for their commute had a higher tendency to use MaaS be it available. Matyas & Kamargianni (2021) suggested that bike users, although not having the strongest intention to use MaaS packages, were willing to at least explore such option. Caiati et al. (2020), on the other hand, found that people were much less willing to subscribe to MaaS when in their daily trips they mainly travelled by walking or used bicycle. Similar to driving, Zijlstra et el. (2020) found no clear effect for cycling on intention to adopt MaaS.

2.5.4. Conceptual Framework

Although scientific interest in understanding the MaaS acceptance and behavioural responses to MaaS has grown recently, there is still no consensus as to what the complete set of factors driving MaaS acceptance and use looks like. The identified literature generally suggests that it is individual demographics, general attitudes, and past behaviour that drive the interest in MaaS. Yet, as in the case of socio-demographics and past behaviour, these studies do not agree which specific items do, and which do not, have an impact. As for attitudes, a number of psychological technology acceptance theories have already been tested quantitatively, and a wide variety of attitudes have been generated qualitatively, but, similarly to the demographics and past behaviour, no consensus has been found as to what should be considered as universal attitudinal drivers of MaaS adoption. Therefore, this study makes its purpose not only to investigate the likelihood of unsustainable travel behaviour occurring with the presence of MaaS, but also to generate more insights regarding the attitudes that form travel behavioural intentions with MaaS whilst also testing these attitudinal items, socio-demographics, and past behaviour variables in a more systematic way. More precisely, this study will determine, using literature as a starting point for the investigation, what are the more specific attitudes of transport users that determine MaaS acceptance and travel behavioural intentions with MaaS. Also, this study will test the effect of these identified attitudes alongside the identified socio-demographic variables, namely age, gender, household composition, employments status, level of education, household income, and the type of residential location,

and the identified past behaviour items, namely car ownership, use of car, public transport, publicly shared cars, and bicycles, as well as walking, on travel behavioural intentions with MaaS. Thus, the investigation in this study will follow, but also improve, the conceptual framework presented on Figure 2.5.1.

Figure 2.5.1: Conceptual Framework

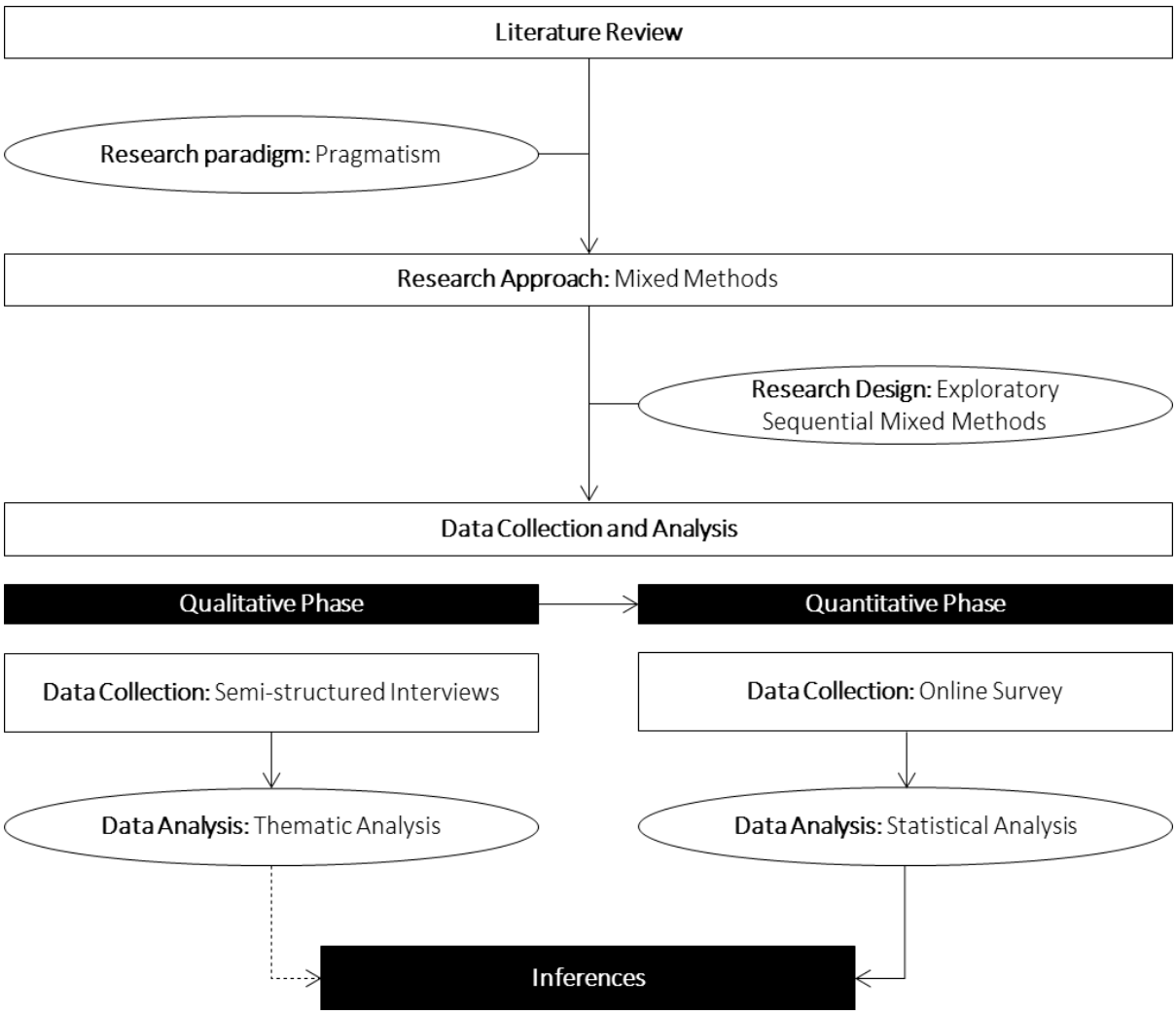


CHAPTER 3. METHODOLOGY

3.1. Introduction

Mixed methods research is an approach to scientific inquiry that involves collecting and integrating two forms of data – qualitative and quantitative. The core assumption of this form of inquiry is that the integration of qualitative and quantitative data yields additional insights beyond the information provided by either type of data alone (Creswell & Creswell, 2018). The author adopted a mixed methods approach to the scientific inquiry presented in this thesis. Thereby, this Chapter discusses the reasons for the selection of the specified approach to search for answers to this study's research objectives, the type of mixed methods design employed, the methods used to collect and integrate qualitative and quantitative data, and the strategies for ensuring rigour throughout the research process. Figure 3.1.1 below depicts the overall research strategy that this study followed.

Figure 3.1.1: Research Strategy



3.2. Reasons for choosing Mixed Methods Approach

According to Creswell (2014), the selection of the research approach should be based, first of all, on the nature of the research problem being addressed, but also aim to overcome the methodical limitations and be driven by researcher's personal experiences and philosophical and theoretical considerations. So, the author chose to adopt a mixed methods approach first due to the nature of the research aim and objectives that were developed, the conceptual framework based on the reviewed literature sources, and the methodological approaches used in addressing similar problems. The decision was also influenced by the author's philosophical standing and her pragmatic worldview, as well as by the ability of mixed methods research to overcome the limitations of mono-method research and produce robust answers to the research questions.

3.2.1. Research Aim and Objectives

As discussed in the previous chapters, this scientific inquiry sets as its purpose to generate insights regarding MaaS' travel behavioural implications and its ability to inspire a more sustainable use of transport. More specifically, this scientific inquiry aims *to develop the empirical understanding of potential travel behavioural implications of MaaS identifying opportunities and challenges in its ability to create sustainable travel behavioural change and produce evidence-based recommendations for policy makers and mobility providers to support sustainable travel behaviour with MaaS*. Achieving this can happen through fulfilling the following objectives:

(I) To explore the factors underpinning the acceptance and travel behavioural intentions of transport users in response to MaaS identifying challenges and opportunities in creating genuinely sustainable travel behaviour; and

(II) To establish the relationships and dynamics between the identified factors and MaaS induced acceptance and travel behavioural intentions.

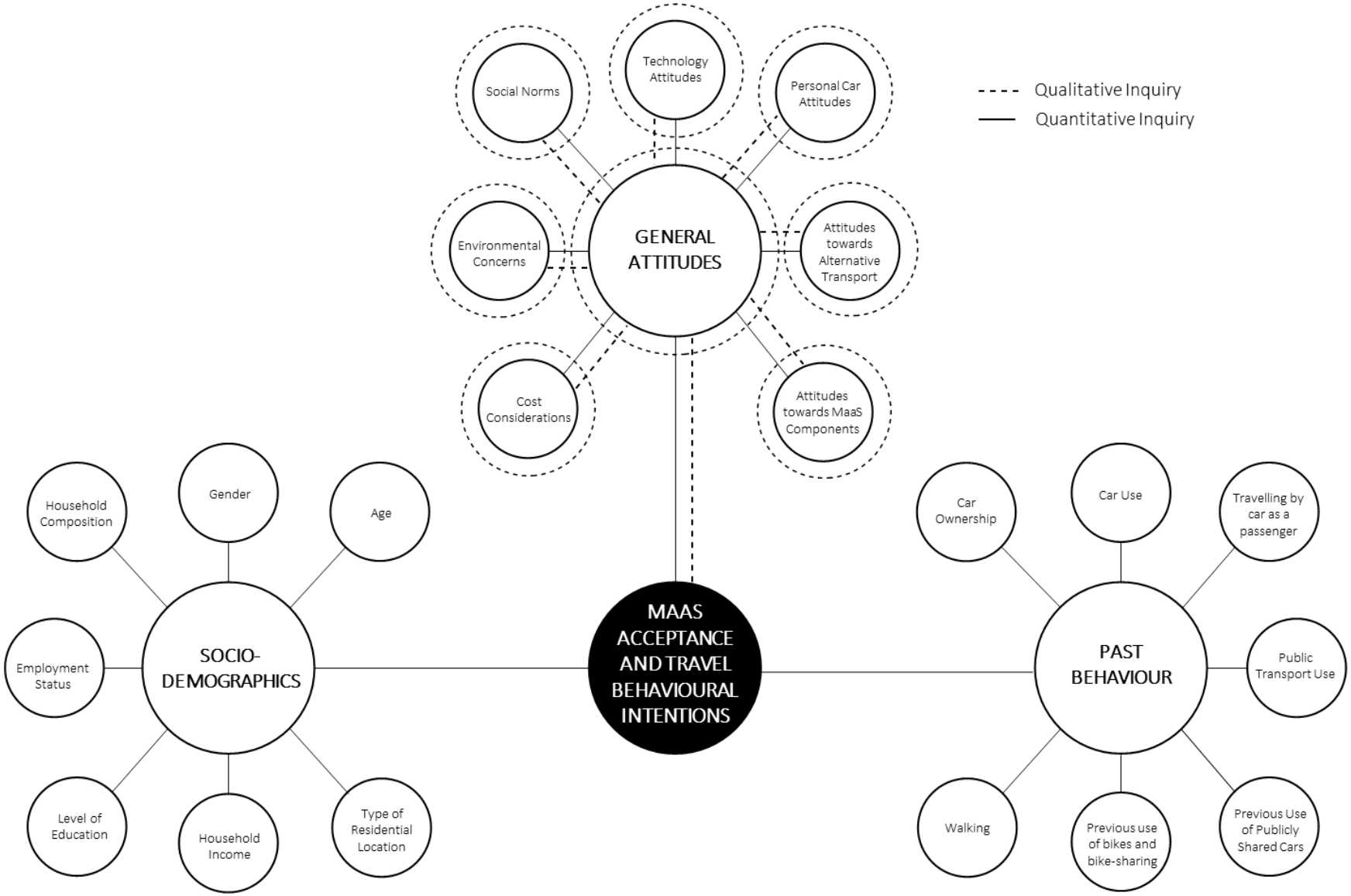
As evident from the literature review, the behavioural implications of MaaS are controversial. The research examining the factors affecting MaaS travel behavioural response argues that MaaS acceptance and use are influenced by a variety of attitudes, but also past behaviour and socio-demographic features; the knowledge regarding the driving attitudes is, however, sparse, and insufficient. By fulfilling objective (I) this study aims to explore the specific attitudes that determine MaaS travel behavioural intentions, and the explorative, inductive nature of this objective implies

the use of qualitative approach. Objective (II) is of confirmatory nature, implying the testing of the established via the literature review and qualitatively factors against travel behavioural intentions on wider group of transport users, and, therefore, requires the use of quantitative methodology. The overall aim of the study is of analytical nature, requiring the integration of both qualitative answers to objective (I) and quantitative answers to objective (II). Thus, to serve its purpose of identifying opportunities and challenges in ability of MaaS to inspire sustainable travel behaviour change and producing relevant recommendations for policy makers and mobility providers that will support sustainable uptake of MaaS, this study requires the integration of qualitative and quantitative approaches to scientific inquiry.

3.2.2. Conceptual Background

According to this study's conceptual framework, MaaS acceptance and travel behavioural implications of MaaS implementation are influenced by three sets of factors: general attitudes, individual socio-demographic characteristics, and past behaviour. The effect of these factors on MaaS acceptance and travel behavioural response is not straightforward, therefore further investigation is required. While the socio-demographic variables and past behaviour items could easily be tested using purely quantitative methodologies, attitudinal variables in the case of this scientific inquiry are not well defined by previous research to be tested quantitatively and, therefore, it is necessary to elicit the relevant attitudes anew using qualitative inquiry prior quantitative testing. Similar approach to studying attitudinal drivers of MaaS acceptance has already been applied in the work of Schikofsky et al. (2020), for an instance. Notably though, this study explores the nature of hypothetical travel behaviours, or in other words travel behavioural *intentions,* that MaaS could induce, as studying the drivers of actual MaaS induced travel behaviour of transport users is not possible at present due to the absence of access to fully functional MaaS scheme users or lack of resources for designing a pilot study. So, to study the role of the identified via literature factors in the formation of MaaS-induced travel behavioural intentions the author adopts the mixing of qualitative and quantitative methodologies. First, the specific attitudinal drivers of MaaS acceptance and travel behavioural intentions are elicited qualitatively to enhance this study's conceptual framework; then, based on qualitative findings, the suitable for quantitative inquiry attitudinal variables are created and tested, alongside socio-demographic characteristics of individuals and past behaviour items, against specific travel behavioural intentions to establish the effect of those on intentional behaviours. Figure 3.2.1 below determines how the developed conceptual framework fits with the selected mixed methods research approach.

Figure 3.2.1: Mixed Methods Conceptual Framework



3.2.3. Philosophical Considerations and Pragmatic Worldview

At times individuals endeavour to grasp noetic ideas they all unwittingly philosophise. The essence of truth, existence and reality, the nature of concepts is what philosophy aims to clarify. It seeks to establish the foundations for knowledge, its origins, and early canons (Adams et al., 2014; Williams & May, 1996). It is the philosophical underpinnings and the spirit of curiosity that motivate individuals to research. Though, in their quest for answers the researchers must be precise. Therefore, it is generally the process of investigation that is defined as research, the methodical investigation that involves collecting, analysing, and interpreting data with the aim to comprehend, characterise and control the phenomenon under study and, consequently, form knowledge (Mertens, 2020). To research means to look for answers, and the validity of those answers strongly relies upon the way the investigation is conducted. The application of systematic methods is paramount for the development of clear understanding and interpretation of the research problems (Williams & May, 1996). Thus, appointing a paradigm to research is of primary importance (Martens, 2020).

Paradigms are the worldviews or belief systems (Tashakkori & Teddlie, 1998) that define the motive for research and the expected outcomes, dictate the appropriate methodology and methods, and, therefore, enable accuracy, structure, and coherence during the research process. Research paradigm in itself combines the *ontology*, which relates to researcher's beliefs about the nature of reality and humanity, and *epistemology*, or the theory of knowledge that informs the research and explores the relationship between the researcher and the knowable (Lee, 2011). Although a number of theoretical paradigms exist, in the social and behavioural sciences these have traditionally fallen into two confronting camps – the Positivist and the Constructivist schools of thought, which the so called 'third view' – Pragmatism – aspires to overcome (Tashakkori & Teddlie, 2009).

The Positivist paradigm was influenced by such philosophers as Aristotle, Bacon, Locke, Comte, and Kant (Mackenzie & Knipe, 2006). Following the *naïve realist* ontology (Denzin & Lincoln, 2018), Positivism assumes there are the laws of universe, the mathematical rules, that govern social events, and the understanding of the phenomena under study is enabled through uncovering these laws. Positivists' epistemological considerations are *objectivist* (Denzin & Lincoln, 2018), meaning that reality exists independently of any conscious mind and, thus, the researcher is an outsider to the research who controls solely the research process. This paradigm can be referred to as

scientific and is often used in research that aims to test theories or hypotheses, dictating the use of *quantitative* approaches. Advocated by Guba, Lincoln, and Denzin (Lee, 2011), Constructivist paradigm is a worldview alternative to Positivism. The Constructivist ontology is *relativist* and assumes there are multiple realities all subject to individuals' thinking about the world. Being *subjectivist* in their epistemological considerations, Constructivist researchers impose the meaning on the studied subjects, believing the knowledge to be the result of human activity, or construction (Denzin & Lincoln, 2018), and as a rule employ *qualitative* approaches in their research (Tashakkori & Teddlie, 2009).

It is evident that the Positivist and Constructivist paradigms are quasi located on the opposite sides of the paradigmatic scale, with so called 'purist' researchers advocating the incompatibility thesis (Howe, 1988), which postulates that qualitative and quantitative research paradigms and their associated methods, cannot and should not be mixed. Pragmatism, whose origins are often attributed to Pierce, James, and Dewey (Johnson & Onwuegbuzie, 2004), is the alternative paradigm that in a way bridges the gap between the confronting worldviews and the associated qualitative and quantitative methodologies. There are no clear epistemological and ontological assumptions relating to the Pragmatic approach: while Positivists assume there is one reality that needs to be comprehended, and Constructivists believe in the concept of multiple realities and subjective truths, Pragmatic views put such issues aside and, agreeing there are singular and multiple realities that are open to empirical inquiry, focus on solving the real-world, practical problems (Feilzer, 2010; Tashakkori & Teddlie, 2009). Thus, the pragmatic researcher is free of constraints imposed by the classic paradigms and does not have to stick to purely quantitative or purely qualitative methods and techniques but is able to use either and even combine them, given they investigate the diverse understandings of the phenomena (Johnson & Onwuegbuzie, 2004) and, ultimately, provide the answers to the questions that are, originally, the drivers of Pragmatic research (Tashakkori & Teddlie, 2009).

The Pragmatic worldview quite precisely reflects the beliefs on the nature of reality, truth, and knowledge, possessed by the author. Moreover, it was the developed research questions that inspired and laid the foundation for the scientific inquiry, presented in this thesis, and the essence of the developed research questions is such that answering them assumes the use of both qualitative and quantitative approaches, which the author genuinely considers compatible and complementary rather than confronting. For the above reasons, the author positions herself as a

Pragmatist researcher, and, therefore, assigns the Pragmatic paradigm to this scientific inquiry and employs a mixed methods approach to research.

3.2.4. Enhancing Strengths and Overcoming Weaknesses of Mono-Methods

The classic paradigms, Positivist and Constructivist, dictate the application of purely quantitative or purely qualitative methodologies. Applying either methodology independently, of course, has its benefits but also drawbacks (Johnson & Onwuegbuzie, 2004). So, the quantitative methodology tests the already established theories, and the outcomes can be hypothesised before the data collection. Though, by focusing solely on theory or hypothesis testing rather than generation, the quantitative researcher may miss out on occurring phenomena. Quantitative approaches also allow for the generalisation of research findings when the data is collected from a sufficiently large sample. They also eliminate the many variables suggested in theories and focus on those that matter the most for the research. The theories applied to study the population, however, may not adequately reflect its specific features, while the representatives in the sample may not be an actual representation of the population under study. As the researcher who applies quantitative paradigms is an outsider to the process, the findings are considered independent of him or her and thus unbiased. The data collection itself is relatively quick, and the data collected is precise and numerical, enabling the analysis that is less time-consuming. The knowledge produced, however, may be too vague and general to be directly applied to specific situations or contexts.

The qualitative methodological approaches also offer a significant number of advantages when utilised in the research process. The data, collected qualitatively, derives the meaning from the participants of the research, and is useful in explaining complex phenomena. This feature is particularly useful when in depth study of a limited number of cases is required. The researcher defines the settings for the research process as they relate to the phenomenon. The researcher is also enabled to generate theories and hypotheses that are responsive to specific situations and conditions. Qualitative researchers are responsive to changes that may appear during research process and can easily shift the focus of their studies if necessary. However, while the quantitative research findings are generalisable, the knowledge produced during qualitative study may not be applicable to situations other than the focus of the study. Neither qualitative approach offers the capacity for testing theories and hypotheses once they are generated. Additionally, the collection and analysis of qualitative data is very time-consuming when compared to that of quantitative data, while the findings themselves are more likely to be biased.

The adoption of mixed methods approach, as opposed to mono-method research, allows the researcher to use the strengths of an additional method to overcome the weaknesses in another method. So, the research is able to answer a broader and more complete range of questions using qualitative and quantitative dimensions. The theory in mixed methods approach can be both generated and tested, increasing the generalisability of results. The narrative data, gathered qualitatively, can be used to add meaning to numerical data gathered at quantitative stages, while numerical data can be used to add precision to narratives and words. Thus, through convergence and corroboration of qualitative and quantitative findings stronger evidence can be delivered. All in all, qualitative and quantitative research combined produce more complete knowledge necessary to inform theory and practice. For the above reasons, the author considers mixed methods a robust approach which facilitates the development of stronger understanding of the research problem and questions, and therefore adopts it in this scientific inquiry.

3.3. Research Design

Bryman & Bell (2011) define Research Design as a framework for the collection and analysis of data and also the criteria that are employed when evaluating research process. It is, therefore, a framework for the generation of evidence that is suited both to a certain set of criteria and to the research question in which the investigator is interested. This section of the thesis presents the research design framework, adopted for this scientific inquiry, and discusses the criteria and strategies used to ensure rigorous research process and research inferences.

3.3.1. Types of Mixed Methods Research

According to Tashakkori & Teddlie (2009), the true mixed methods design refers to the types of scientific inquiry that have at least two strands, the qualitative and quantitative. The research strand can be defined as a phase of research that involves three stages: the *conceptualisation* stage, where the research purpose and the abstract procedures are formulated; the *experimental* stage, including both data *collection* or data *analysis*; and the *inferential* stage, where the findings are generated. The design typology in mixed methods research is majorly concerned with the *timing* when the qualitative and quantitative strands occur and the points of *integration* where the qualitative and quantitative components are brought together (Schoonenboom & Johnson, 2017). With regards to timing, the mixed methods designs can be either *parallel*, where research strands occur in parallel manner, either simultaneously or with some time lapse, and address related

aspects of the same research question, or *sequential*, where the strands occur chronologically, with one phase emerging from or following the other, and with research questions and procedures for one strand depending on the previous strand (Tashakkori & Teddlie, 2009). Mixed methods studies also have at least one, but often more, integration points, and any stage of a strand offers potential to become the point of integration (Schoonenboom & Johnson, 2017).

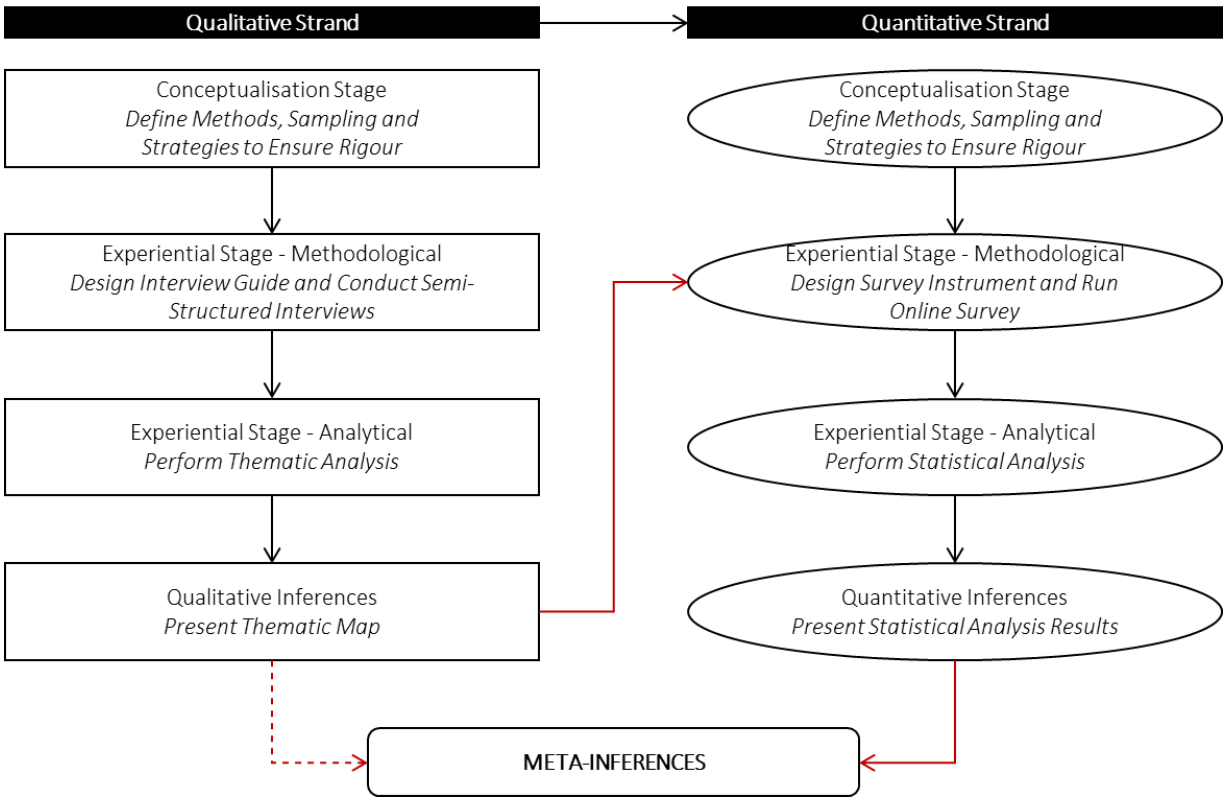
Combining the lines of work by Creswell & Creswell (2018) and Tashakkori & Teddlie (2009), three core types of mixed methods research designs are determined, those being parallel mixed design, explanatory sequential mixed design, and exploratory sequential mixed design. *Parallel designs*, also referred to as *convergent* by Creswell & Creswell (2018), have at least two parallel and relatively independent strands: the researcher collects, using two different methods, both qualitative and quantitative data that provide independent of each other types of information, and separately analyses the two datasets using different analysis techniques. The inferences of both strands are then integrated in a form of a *meta-inference* and are used to answer the overarching mixed methods research question. The *sequential designs* involve two, or more, strands that appear chronologically, and the second strand of the study is conducted either to confirm or disconfirm inferences from the first strand or to provide further explanation for its findings. The sequential designs can be either *explanatory*, where quantitative data collection and analysis precede the qualitative phase of the study, and the findings of quantitative phase are used to inform the qualitative procedures, or *exploratory*, where the qualitative data collection and analysis precede the quantitative phase, and the findings of the qualitative phase are used to build a feature to be tested quantitatively (Creswell & Creswell, 2018). In these sequential approaches the point of integration occurs not only when the inferences of one strand feed into the formation of the consequent strand, but the inferences of the two strands are also combined at meta-inferential stage. Though often far more time-consuming than the parallel designs, sequential designs are less complicated to conduct by a researcher because it is easier to keep the strands separate, and the studies typically unfold in a slower, more predictable manner.

3.3.2. Exploratory Sequential Mixed Methods Design

Given the nature of the research problem and the emergent research questions, this scientific inquiry utilises the *exploratory sequential mixed methods design*. Figure 3.3.1 presents the graphic illustration of the research process starting from conceptualisation stages all the way to inferential stages. The points of integration of this scientific inquiry are signposted as red arrows. It is

important to note that the conceptualisation stages for both qualitative and quantitative strand occur in parallel manner, with the methods and sampling procedures conceptualised in the following sections of this chapter. The qualitative and quantitative strands will be presented, from methodological experimental stages to analytical experimental stages to inferential stages, in the chapters to follow. Thus, the study, consists of two distinct research phases – qualitative and quantitative – and the qualitative strand precedes the quantitative strand. The qualitative strand is designed with the aim to understand the underlying process of travel behavioural intentions formation with MaaS, the type of inquiry that is generally referred to as theory generation (Turner et al., 2015). The quantitative strand is designed with the aim to test whether there is an effect of the qualitatively defined process on the MaaS induced travel behavioural intentions, and what that effect is, which is generally referred to as theory testing (Turner et al., 2015). This scientific inquiry has two points of inferential integration: first, the inferences of qualitative strand are used at the methodological experimental stage of quantitative strand to design the quantitative data collection tool; then, the inferences from qualitative and quantitative strands are combined as meta-inferences, with quantitative inferences used to check for conformity or contradiction to qualitative inferences, and qualitative inferences used to provide explanations to the effects established quantitatively, thereby meeting the overarching research aim.

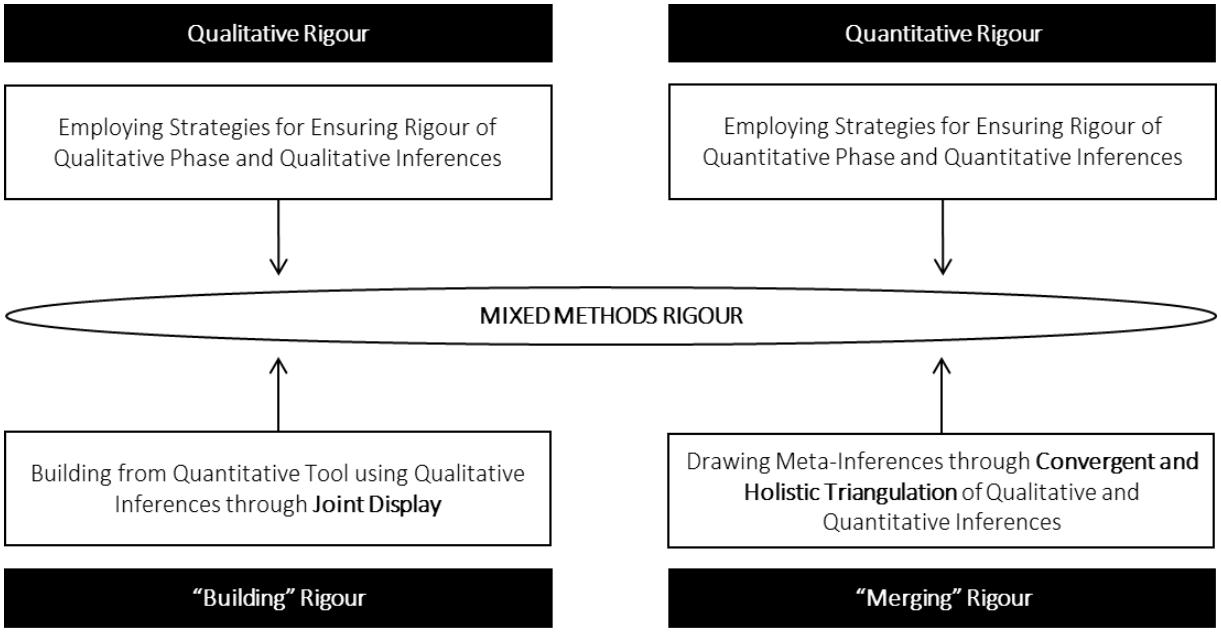
Figure 3.3.1: Exploratory Sequential Mixed Methods Design
Adapted from Tashakkori & Teddlie (2009)



3.3.3. Achieving Mixed Methods Rigour

According to Tashakkori & Teddlie (2009), to ensure mixed methods rigour researchers must employ three sets of strategies. First, they must set the strategies for ensuring rigour of the two (or more) strands of the mixed methods inquiry, meaning distinctive criteria for qualitative and quantitative strands must be adopted. Then, the researchers must assess the rigour of meta-inferences based on integration of inferences from quantitative and qualitative strands. Thereby, this chapter section focuses on establishing the strategy for mixed methods rigour, graphic representation of which is provided on Figure 3.3.2. The detailed strategies for ensuring rigour of qualitative and quantitative strands are provided in the following sections of this chapter.

Figure 3.3.2: Approach to Mixed Methods Rigour



Merging strategies have been described by Turner et al. (2015) as various forms of data triangulation. More specifically, the authors distinguish three types of triangulation for mixed methods research: convergent triangulation, holistic triangulation, and a combination thereof. The convergent triangulation strategy is concerned with either theory testing, where two research strands of a mixed methods inquiry are used to test the same theory, or with development and consequent testing of a theory, with one strand of mixed methods inquiry focusing on theory development and another one focusing on theory testing. The holistic triangulation strategy, in its turn, is concerned with utilising a mix of research strategies to learn different and unique things about the phenomenon under investigation.

As in this scientific inquiry the author aims to obtain better understanding of MaaS travel behavioural implications through developing a set of factors driving intentional travel behaviour with MaaS and testing the latter, and also through the unique perspectives qualitative and quantitative methods could provide, the mix of *convergent and holistic triangulation* strategies, reinforced by strategies for rigour of qualitative and quantitative strands, had been adopted for ensuring meta-inferential, *"merging" rigour*. To ensure *"building" rigour* the author utilised the *joint display* strategy (Harrison et al., 2020b). When used for sequential mixed methods designs, joint displays link qualitative and quantitative inferences in a form of a table or graph and show how the results from one strand influence the data collection in the subsequent strand (Creswell & Plano Clark, 2017).

3.4. Conceptualisation of Qualitative Phase

As already mentioned in the previous sections of this chapter, the first major objective the author aims to fulfil through this scientific inquiry is:

(I) To explore the factors underpinning the acceptance and travel behavioural intentions of transport users in response to MaaS identifying challenges and opportunities in creating genuinely sustainable travel behaviour.

Therefore, the first strand of this study is of explorative nature and aims to *generate* a set of factors that underpin transport user travel behavioural intentions with MaaS, which implies the use of a qualitative approach. Despite the important role qualitative methods can play in travel behaviour analysis grounds, they have been scarcely used in the literature and studies concerned with MaaS (Matyas, 2020). This section of the thesis provides the conceptualisation of the qualitative phase of this thesis, starting with the presentation of the data collection method and the reasons for the choice. The discussion of sampling and recruitment procedures proceeds the section. Then, the method of analysis is presented, followed by the strategies for ensuring rigour in qualitative research.

3.4.1. Data Collection Method

Individual semi-structured interviewing based on an *interview guide* was chosen over other qualitative methods as this method, although laborious, allows the researcher to get rich data (Walle, 2015) and understand the reasons for the decisions individuals make by capturing their

attitudes, views, beliefs, and opinions (Saunders et al., 2016), which is particularly useful given the essence of the research question the qualitative phase of this study is meant to provide the answer for. This data collection method is also appropriate when participants have a low level of awareness of the subject under study (Kallio et al., 2016), which is the case with MaaS in the United Kingdom: there are no active, full-scale MaaS schemes and applications transport users could have real-life experience with, except Whim pilot scheme with limited functionality in the West Midlands (House of Commons, 2018). An alternative to the individual semi-structured interviewing could have been the use of focus groups, a method of interviewing that involves more than one, usually at least four, interviewees (Bryman & Bell, 2011). During group discussions, however, dominant individuals could influence the direction of answers of the whole group, resulting sometimes in rarely held beliefs and opinions accounted for as commanding for the whole group of participants (Fishbein & Ajzen, 2010). This was the main reason why individual interaction was given a preference to in this study.

An interview guide can be referred to as a structured list of issues to be addressed or questions to be asked in semi-structured interviewing (Bryman & Bell, 2011). Thus, when conducting a semi-structured interview, the author relied on an interview guide, or a list of questions on fairly specific topics to be covered. The interview guide itself was developed following the line of work by Kallio et al. (2016), with major steps of retrieving and using previous knowledge and piloting the preliminary interview guide before its full-scale implementation undertaken. According to Bryman & Bell (2011), the interview guide does not have to consist solely of words and questions but can also include the graphical representations of the subject matter under investigation. In this scientific inquiry, an infographic had to be developed in order to aid interview participants' familiarisation with and understanding of the novel concept of MaaS and, thus, ensure their answers to MaaS related questions were well informed. Infographics provide an engaging visual display communication tool that offers to researchers the ability to present intense and sophisticated information on a certain subject in a more comprehensible manner (Dur, 2014). The process of interview guide development, including the infographic development, are presented in detail in Chapter 4 Qualitative Phase and Analysis.

3.4.2. Sampling Approach

Sample, according to Gideon (2012) is a group of elements, selected from a population, that is an entire group of elements that the researcher wants to describe and understand, with the

assumption that studying the former will reveal important information about the latter. Two types of sampling methods can be identified in the literature: the probability (Wolf et al., 2016), also referred to as random (Gideon, 2012), and non-probability (Wolf et al., 2016), also referred to as non-random (Gideon, 2012), sampling. When adopting probability sampling, the researcher gives a known, non-zero, probability of inclusion to every element in the population of interest and selects the study objects *randomly,* or in other words predefines them by some objective procedure (Fowler, 2014). The main benefit of such sampling approach is believed to be its ability to provide inferences generalisable to the whole population. The non-probability sampling, on the other hand, is a sampling method that does not conform to the canons of probability sampling (Bryman & Bell, 2011), and the study objects, therefore, have no known probability of being included but are rather purposely selected by the researcher or are given an opportunity to volunteer, or self-select (Wolf et al., 2016).

The population the author aimed to understand through this qualitative inquiry is the adult, meaning the age of 18 years or older, general public of the UK, also referred to as transport users. The UK general public was selected as those were easily accessible by the author who herself was based in the UK during the research period. Given the explorative nature of this stage of the scientific inquiry and, thus, needlessness of statistical inferences about the characteristics of studied population (Saunders et al., 2016), *non-probability sampling* methods were used. A mix of *self-selection* sampling, where individuals chose to take part in the study on their own accord once the latter was advertised to them, and the *snowballing* sampling, where the already recruited participants suggested future participants from among their acquaintances, were adopted (Saunders at al. 2016; Wolf et al., 2016). The researcher, however, also had to adopt *purposive* sampling technique, the idea of which is to follow researcher's own judgement with the idea to create a representative or diverse sample (Wolf et al., 2016). Thus, the researcher also selected individuals, from those already identified for the study using the self-selection and snowballing techniques, who would compose a sample that is *diverse* in terms of age, gender, marital and family status, educational background, employment types, levels of income, driving license availability, household car ownership, and places of residence.

3.4.3. Method of Analysis

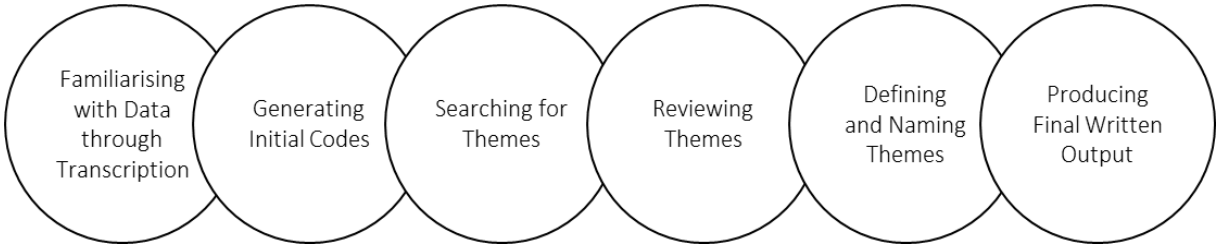
Inspired by the six-step Thematic Analysis approach proposed by Braun & Clarke (2006) this scientific inquiry adopted the systematic line of work by Nikitas et al. (2018, 2019). Thematic

Analysis is a method for identifying, organising, and offering insights into patterns of themes across several items of qualitative data. It provides the mechanics of systematically coding and analysing data and linking it to broader theoretical concepts. The key concept of Thematic Analysis is the identification of *themes* within qualitative data. A theme in Thematic Analysis is not necessarily something that many items in a dataset pay substantial attention to; it is possible for a theme to emerge even if it appears in a relatively little proportion of interview participants' responses, as long as it captures something important in relation to the overall research question. Themes often have *sub-themes*, or in other words sub-categories, that uncover a pattern in the participants' answers.

The Thematic Analysis process, according to Braun & Clarke (2006), involves six steps, presented on Figure 3.4.1. First, the researcher *familiarises with the collected data* by transcribing, reading, and re-reading the interview participants' responses, and noting down the initial ideas regarding grouping decisions. Then, the researcher starts *generating the initial codes* by capturing interesting features of the collected data and assigning them to relevant codes. After, the initial *search for themes* takes place: the codes are collated, and all the relevant data is gathered into initial themes. The next step involves *reviewing themes* by checking how the identified themes work in relation to codes and the entire dataset and, ultimately, creating a so-called thematic map of the analysis. The analysis proceeds with the researcher *defining and naming themes* by giving themes the definitions and names that clearly tell the overall analysis story. Finally, the researcher *produces the written output* of the findings, with most vivid and compelling textual extracts supplied to uncover the meaning of each theme. Unlike other qualitative methods, Thematic Analysis is not devoted to any research paradigm, and, therefore, is an analysis method suitable for either reflecting reality or unravelling the surface of reality (Braun & Clarke, 2006). Neither does Thematic Analysis require the detailed theoretical and technological knowledge of approaches, like in the case of Grounded Theory, thus it offers a more accessible and easily comprehendible form of analysis, particularly for those early in a qualitative research career, which applies to the author.

Figure 3.4.1: Thematic Analysis Process

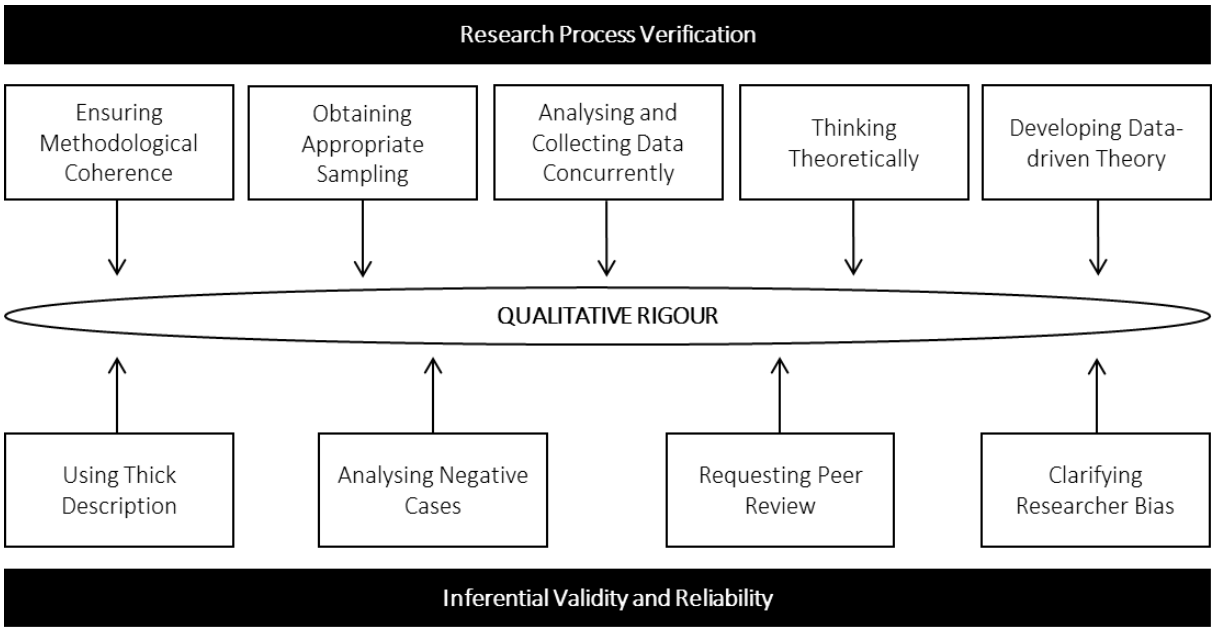
Adapted from Braun & Clarke, 2006



3.4.4. Achieving Qualitative Rigour

The key to the utility of qualitative research lies in its rigour (Morse et al., 2002) that is often far more difficult to achieve than in quantitative research; hence, reliability and validity of qualitative research are paid a great deal of attention to. Validity in qualitative research determines whether the findings are accurate from the researcher's, the participants', and the readers', viewpoint (Creswell & Creswell, 2018). Reliability, as suggested by Creswell & Creswell (2018), is the extent to which the data collection and analysis procedures are consistent and stable throughout the research process, and whether those would be able to produce the same results if the study were to be repeated (Morse, 2015). Ensuring reliability and validity during the qualitative research process is often cunningly replaced by evaluating the already completed research (Morse et al., 2002). However, when evaluating the rigour of solely the research outcomes the researcher puts oneself at risk of noticing serious threats to the reliability and validity at the point when it is too late to amend qualitative inquiry process and avoid those threats. Therefore, for the purpose of ensuring rigour of the qualitative strand of this scientific inquiry the author adopted evaluation strategies both during the research process and for the outcomes of the latter, presenting the established approach on Figure 3.4.2.

Figure 3.4.2: Approach to Qualitative Rigour



The activities undertaken to ensure validity and reliability throughout the research process are referred to as verification strategies (Morse et al., 2002), and include selecting coherent methods; adopting appropriate sampling; analysing and collecting data concurrently; thinking theoretically;

and developing theory. So, to provide for *methodological coherence* the researcher, and the author, in line with recommendations by Morse et al. (2002) selected the data collection method that is compatible with the research question, justifying the selection of semi-structured interviewing by presenting its ability to gather the type of data relevant for the research phenomenon; the author also selected the non-probability sampling approach that, as evident from the presented literature, is compatible with the semi-structured interviewing data collection method; then, a rather flexible method of analysis was selected by the author to make sure it fits whatever data provided by the sample; and lastly, the author considered adjusting the selected methods, as opposed to initial planning, if required by the collected data. To ensure *appropriate sample* the researcher aspired to recruit participants able to provide knowledge relevant to the research topic and aimed for the number of participants that would allow for the point of *saturation*, where the collected data begins to provide little, if any, new information, to be achieved. Achieving saturation means that the collected data is sufficient to account for all aspects, also the negative, contradicting ones, of the phenomenon under study. When recruiting participants for the study, the author, however, also took into consideration the theoretical recommendation by Saunders at al. (2016) that the minimum non-probability sample size for semi-structured interviews should be between five and 25.

By following the recommendations for Thematic Analysis (Braun & Clarke, 2006) to immerse in collected data already at the interviewing stage and to come to formal analysis with some initial ideas regarding coding and emerging themes, the author ensured that the *data were collected and analysed concurrently,* and that this initial analysis involved *theoretical thinking*, which stands for reconfirming in new data the ideas that emerged from data already collected and analysed, and initiating new ideas if those had not yet appeared (Morse et al., 2002). To produce a theory, or in the case of this scientific inquiry a Thematic Map, the author, as advised by Braun & Clarke (2006), despite relying on an interview guide based on review of the existing literature, took a data driven approach to theme identification, thereby following the *theory development* strategy (Morse et al., 2002) for research process verification.

To ensure the validity and reliability of findings of the qualitative strand, the author followed the line of work by Morse (2015). Morse (2015) proposes the use of thick description, analysis of negative cases, peer review, and clarifying researcher bias as the most effective strategies for providing validity and reliability to findings gathered through interview research. *Thick description*, where many perspectives about a developed theme are offered in the description of inferences

(Creswell & Creswell, 2018), and *negative cases analysis*, where the evidence of negative cases in line with more commonly occurring cases is provided (Morse, 2015; Tashakkori & Teddlie, 2009), usually result from achieving *saturation* during data collection. The author conformed to the Thematic Analysis guidelines for producing the final written report that dictate the use of specific data extracts as evidence of the theme prevalence and also suggest presenting contradicting elements in the data (Braun & Clarke, 2006), which in essence is providing thick description alongside negative cases analysis. To clarify interpretations of the collected data, the author adopted *peer review* strategy (Tashakkori & Teddlie, 2009) by presenting findings to her two supervisors, who are professionally trained researchers working on other topics.

The author also acknowledged two major sources of *bias* to this qualitative inquiry. First, it was possible for the outcomes of the inquiry to be anticipated prior data collection and analysis. By following the discussed above verification strategies of remaining neutral during data collection and analysis and aiming for data driven *theory development*, the author built solid grounds for obtaining unbiased and, thus, valid results (Morse, 2015). Second, as the sample for this scientific inquiry does not pertain to the rules of random selection and is expected to be small, which is common in qualitative research, the author risked invalidity. The sampling bias is, though, hard to overcome, and avoidance of the latter depends on the ability of the researcher to find the individuals who can provide the most fruitful account of the phenomenon under investigation, which the author pursued during research process by adopting *appropriate sampling* and *saturation* strategies.

Another strategy for ensuring inference validity and reliability, often proposed by methodology experts, is *member checking* (Bryman & Bell, 2011; Creswell & Creswell, 2018; Tashakkori & Teddlie, 2009), which involves asking study participants to check the accuracy of the themes, interpretations, and conclusions once those are produced by the researcher. Morse (2015) suggests, however, that the use of member checking strategy is impractical as the inferences of interview research are based on all of the participants' answers, and those do not necessarily agree; therefore, it is unlikely that a participant will recognise one's own story and approve of researcher's findings.

3.5. Conceptualisation of Quantitative Phase

The second major objective the author aims to fulfil through the scientific inquiry presented in this thesis is related to the findings of the qualitative strand and is as follows:

(I) To establish the relationships and dynamics between the identified factors and MaaS induced acceptance and travel behavioural intentions.

Therefore, the second strand of this study *confirms* the validity of and *establishes the relationships*, or effects, of the identified qualitatively and via literature review factors with MaaS induced travel behavioural intentions among transport users, which implies the use of a quantitative approach. Therefore, this section of the thesis provides the conceptualisation of the quantitative phase of this scientific inquiry, presenting the selected method of data collection, the chosen sampling and recruitment approaches, method of data analysis, and the strategies for ensuring rigour in quantitative research phase.

3.5.1. Data Collection Method

Online self-administered quantitative survey was chosen as the data collection method for the quantitative strand of this scientific inquiry. Self-administered survey, also referred to as self-completion questionnaire (Bryman & Bell, 2011), is a quantitative data collection tool completed by the respondents themselves at the time, place, and pace convenient for them, and also with an increased sense of security – the factors contributing to higher data quality (Fielding et al., 2017). Self-administered survey serves well in measuring attitudes, views, beliefs, and opinions of individuals (Tashakkori & Teddlie, 2003), which the quantitative inquiry presented in this thesis had as its underlying idea. Self-administered survey is a time- and cost-efficient tool for collecting quantitative data (Bryman & Bell, 2011), offering an opportunity to achieve larger samples and produce generalisable results (Harris & Brown, 2010). Being online based and thus having the World Wide Web and e-mail as communication channels, self-administered survey also offers a benefit of *reach*, or the ease of approaching potential respondents, and is particularly attractive as it can target the population distributed across a large geographic region (Van Selm & Jankowski, 2006), which was practical for the author who aimed to study individuals across the UK.

Questions about attitudes, beliefs and opinions are very common in self-administered survey research (Bryman & Bell, 2011). The survey designed for the quantitative strand of this scientific

inquiry collected empirical data through testing 40 attitudinal and five intentional *Likert-scale* statements, derived from the results of Thematic Analysis and formulated using the data extracts presented as evidence for the themes. Likert-scale was originally developed to measure attitudes in a scientifically accepted and validated way (Joshi et al., 2015) and, according to Bryman & Bell (2011), is one of the most frequently encountered formats for measuring attitudes in social and behavioural research. The Likert-scale refers to a set of statements offered for a real or hypothetical situations under study, and the participants of that study show their level of agreement with the statements on a metric scale (Joshi et al., 2015). Thus, Likert-scale statements in survey research are typically considered *ordinal variables*, or special semi-quantitative categorical variables whose values are conceptually ordered (Warner, 2008). According to Lozano et al. (2008), the minimum number of response categories for Likert-scale items should be at least four. Thus, *five-point* metric scales were offered to participants for selection, with the five points for attitudinal Likert-scale statements being *strongly disagree, disagree, nether agree nor disagree, agree*, and *strongly agree*; and the five points for intentional Likert-scale statements being *extremely unlikely, unlikely, neither likely nor unlikely, likely,* and *extremely likely*. Both Likert-scales, as can be noted, offered midpoint options of *nether agree nor disagre*e and *neither likely nor unlikely* for participants' selection. The inclusion of the midpoint options provides a viable option for respondents who genuinely do not hold an opinion regarding a statement and helps avoiding forcing respondents to artificially create opinions (Weems & Onwuegbuzie, 2001).

Survey participants representing general public of the UK were unlikely, like the semi-structured interview participants, to be knowledgeable of the MaaS concept; therefore, an *infographic*, previously used to aid the semi-structured interviewing process, was integrated also within the survey instrument to ensure the answers of survey participants to MaaS related questions were informed. In addition to rankings of attitudinal and intentional Likert-scale statements, the survey collected participants' demographic information. The information regarding participants existing travel behavioural practices, such as household car ownership and frequency of using different transport modes, was also requested. The detailed survey instrument and the process of its development are presented in the Quantitative Analysis and Results Chapter.

3.5.2. Sampling Approach

In social survey research, sampling constitutes a key step in the research process (Bryman & Bell, 2011). Probability sampling is generally accepted in the quantitative survey research as the most

appropriate method for making inferences that can be generalised to a finite population (Brick, 2014). However, often it is difficult and expensive to get responses from a probability sample, particularly a general population sample (Fowler, 2014). Moreover, when inferring from a probability sample to the entire population, a researcher faces the risk of the sample being different to the population under study due to randomisation (Wolf et al., 2016). Thus, the alternative approaches to easing the data collection burden should be explored. Non-probability sampling methods are believed to be best suited for conducting online based surveys as achieving a random sample of Internet users is rather difficult, and at times even impossible (Van Selm & Jankowski, 2006). Even though non-probability samples are as a rule considered not representative for the total population, they can be valuable as they may represent a subgroup of the total population.

Given the above reasons, the *non-probability sampling* approaches were adopted for the quantitative strand of the scientific inquiry, presented in this thesis. The population the author aimed to understand through this quantitative inquiry was the adult general public of the UK as, again, it was the most easily accessible given author's location during the research period. The author adopted survey sampling approaches as proposed in the work of Wolf et al. (2016); thereby, a mix of *self-selection in web* sampling, where individuals volunteered to take part in the study once the calls for participants were posted on various web pages and social media, *convenience* sampling, where researcher's social ties were recruited for the study, and s*nowballing* sampling, where researcher's social ties recruited passed the call for participants onto their acquaintances or via their personal social media means, was used. It is also important to mentioned that the sample was *screened* (Bryman & Bell, 2011) so that only responses from the required population would be obtained for analysis. Thus, the survey participants were questioned whether they were 18 years old or above, and whether at the time of filling in the survey they resided in the UK; if the answer was "no" to either of the questions, the participants could not proceed with the survey, and their responses were later eliminated by the author.

3.5.3. Method of Analysis

Statistical analysis methods are commonly used by behavioural and social scientists to work through quantitative survey data. Similarly, the author adopted *regression modelling*, facilitated by *factor analysis*, and *univariate analysis* of factor analysis results. All the statistical analysis procedures for this quantitative inquiry were performed using IBM SPSS Statistics.

Regression modelling can be defined as a statistical method for investigating functional relationships among variables (Chatterjee & Hadi, 2015). These relationships are usually expressed as equations or models connecting the response, or dependent variable, with one or more explanatory variables. The latter, in ordinal regression models, can be either "factors" (i.e., nominal/ordinal in IBM SPSS) or "covariates" (i.e. scale in IBM SPSS) (McCullagh, 1980). In the case of this quantitative inquiry, the dependent variables are the abovementioned five intentional Likert-scale statements which were previously classed as ordinal; the explanatory variables are the 40 attitudinal Likert-statements. Therefore, to establish the relationships between multiple attitudinal variables and the intentional behavioural variables, though individually, the author adopted *ordinal logistic regression modelling* (Warner, 2008), which is a multiple regression modelling technique used specifically for ordinal dependent variables. However, to discard of the possible unreliable variance in the 40 attitudinal Likert-scale variables (Thompson, 2004), a smaller set of explanatory variables had to be developed.

Factor analysis refers to a family of statistical techniques aimed at simplifying complex sets of variables, with factors developing in the analysis as constructs, or latent variables, that show the condensed relationship between certain variables in the initial set (Kline, 2014). Factor analysis can be used both for developing the theory regarding the nature of the constructs and for creating a parsimonious group of constructs to use in the subsequent analysis, such as regression modelling (Thompson, 2004). Two major types of factor analysis exist: *exploratory factor analysis (EFA)* and *confirmatory factor analysis (CFA).* The researcher, as a rule, bases CFA on the previous studies or existing relevant factor models, directly testing the fit of such models to the available data (Kline, 2014). When performing EFA, the researcher generally does not have any assumptions regarding the nature or number of underlying constructs. EFA, however, can be used for validity investigation, and that is when the researcher may expect certain results; though, those expectations have no influence on the analysis (Thompson, 2004). Thus, factor analysis, and EFA specifically, was adopted by the author to investigate, using the Thematic Map driven attitudinal Likert-scale statements, the relationships, and dynamics between the identified themes and sub-themes to reduce the number of explanatory variables for regression modelling but also in a way test the validity of the developed qualitatively Thematic Map.

For the conduct of EFA, three key steps must be followed: choosing a factor extraction method; choosing the rotation method; and deciding on the number of factors to retain (Costello & Osborne, 2005). The extraction methods to choose from include principal component analysis

(PCA), unweighted least squares, generalised least squares, maximum likelihood, principal axis factoring, alpha factoring, and image factoring (Costello & Osborne, 2005). However, the literature on the use and benefits of those, except for PCA perhaps, is scarce. Thus, when deciding what extraction method to use the ultimate goal of factor analysis to account for as much variance as possible in an initial set of variables with a smaller set of latent variables, or constructs, should be taken into consideration (Hayton et al., 2004). The rotation methods can be selected from either orthogonal or oblique. *Orthogonal* rotation methods, including varimax, quartimax, and equamax, produce the factors, or constructs, that are uncorrelated; *oblique* rotation methods, such as direct oblimin, quartimin, and promax, allow the constructs to correlate. Yet again though, there is no consensus as to what rotation type is best to be used as it is often data-dependent (Cabrera-Nguyen, 2010). In the social sciences, correlations among constructs are generally expected, so it is advised to use oblique rotation; when the constructs are uncorrelated, the EFA with either oblique or orthogonal rotation produce similar results (Costello & Osborne, 2005). The family of multiple regression techniques, including ordinal logistic regression modelling, employed in this quantitative inquiry, are, however, very sensitive to correlations among explanatory variables, a phenomenon called multicollinearity (Tabachnick & Fidell, 2013). Thus, to avoid multicollinearity issues, orthogonal rotation methods were relied upon. Thereby, *principal component analysis (PCA)* with *varimax rotation* were implemented.

Factor retention approach based on *eigenvalues above 1* is one of the most utilised in factor analysis, but, when used alone, is among the least accurate methods for factor retention (Costello & Osborne, 2005). The use of *scree test*, which involves an examination of a plot of the eigenvalues for breaks or discontinuities, is often suggested as a viable alternative; however, it suffers from subjectivity, especially when the breaks on a plot are either not clear or multiple (Hayton et al., 2004). For the above reasons, the approach to factor retention proposed by Anable (2005), where the developed through EFA constructs are tested for internal reliability using *Cronbach α,* was selected. Again, there is no consensus as to what value of Cronbach α should be considered a benchmark for factor retention; it is often suggested, though, that factor reliabilities below 0.7 are not acceptable (O'Leary-Kelly & Vokurka, 1998) – the rule obeyed by this quantitative inquiry.

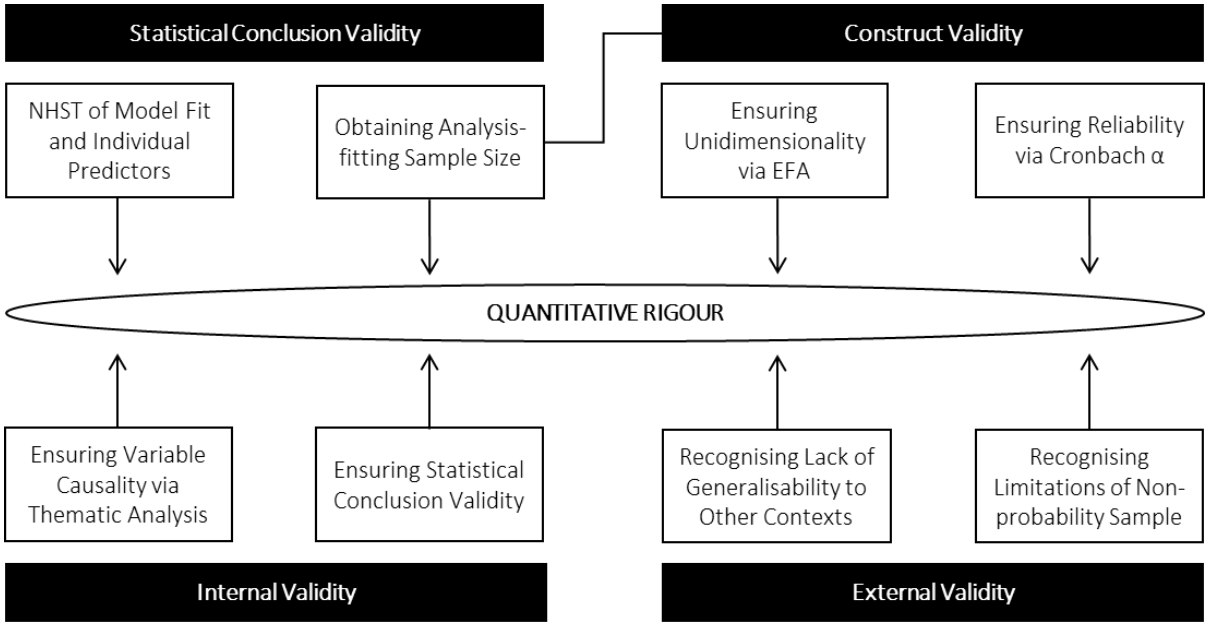
Univariate analysis refers to the analysis of one variable at a time (Bryman & Bell, 2011). In the quantitative strand of this scientific inquiry, the univariate analysis was used first to present the study participants' level of agreement with the developed Likert-scale statements, grouped according to factor analysis results. To do the latter, *bar charts,* which provided visual display for

frequency tables, or the tables presenting the number and percentage of study participants belonging to each of the categories for the variable in question, were adopted. Presenting the *measures of central tendency*, which encapsulate a value typical for the distribution of values across the whole sample, was another technique adopted. As the amount of variation in a sample can be just as interesting as providing estimates of the typical value of a distribution, a combination of *mean*, or the average for the whole sample score for each Likert-scale statement, and *standard deviation*, which is essentially the average amount of variation around the mean, were adopted in this quantitative inquiry.

3.5.4. Achieving Quantitative Rigour

Quantitative rigour heavily relies on ensuring validity of quantitative findings. Quantitative validity, according to Shadish et al. (2002), refers to approximate truth of an inference. Validity in quantitative research is just as important as in qualitative research, however it can be measured, at least in part, in a more systematic and straightforward way through various statistical tests. Although a variety of approaches to ensuring quantitative validity exist, in this quantitative inquiry the author employed the approach highlighted by Tashakkori & Teddlie (2009) and initially proposed by Shadish et al. (2002), which suggests that quantitative validity can be achieved through ensuring *statistical conclusion validity*; *internal validity*; *construct validity*; and *external validity*. The schematic representation of the adopted approach is presented on Figure 3.5.1., and the details on each of the four criteria are discussed below.

Figure 3.5.1: Approach to Quantitative Rigour



Statistical conclusion validity is concerned with accepting or rejecting the null hypothesis, which determines whether the statistical modelling results, or inferences, appeared because dependent and explanatory variables actually covary, or whether those results appeared by chance (Bryman & Bell, 2011). Rejecting the null hypothesis when it should be accepted is considered a Type I error in quantitative research and means the researcher incorrectly concluded that the independent variables, or hypothesized cause (Onwuegbuzie, 2000), and the dependent variable, or hypothesized effect, covary in the studied population when in reality there is no such relationship; accepting the null hypothesis when it should be rejected is considered a Type II error in quantitative research and means the researcher incorrectly concluded that cause and effect do not covary when they actually do (Shadish et al., 2002). This largely depends on researcher's decision regarding the level of significance (*p*) for the tests to adopt. In social and behavioural sciences, the commonly adopted *p* value benchmark is 0.05, with anything less than 0.05 implying statistical significance, and no statistical significance otherwise (Petrucci, 2009). So, *null hypothesis significance testing (NHST)* is the most commonly utilised way of ensuring statistical conclusion validity.

In ordinal logistic regression modelling the inferential null hypothesis significance testing approaches generally used are the tests of model fit and the tests of individual predictors (Tabachnick & Fidell, 2013). To test the fit of the developed ordinal logistic regression model the author adopted a mix of likelihood ratio Chi-square test, Pearson Chi-square and deviance test, and the test of parallel lines. *Likelihood ratio Chi-square test*, where the model without any independent variables, or intercept model, is compared to the final developed model with all independent variables, is the most commonly used technique for model fit assessment (Petrucci, 2009). Here, the −2 log likelihoods for each model are subtracted from one another to produce the Chi-square and significance values, with statistical significance suggesting model fit. Another approach to model assessment is comparing the final model to a perfect hypothetical model (Tabachnick & Fidell, 2013). In this case, the *Pearson Chi-square* and *deviance statistics* asses the fit of the model, and to prove model fit the statistical significance for either is not desired (Petrucci, 2009). Ordinal logistic regression models also hold an assumption that the correlation between the independent variables and categories of dependent variable does not change, implying the categories are parallel to each other (Norusis, 2012). This assumption is assessed using *the test of parallel lines*, where the null hypothesis model, containing –2 log-likelihood for the model that assumes the categories' parallelism, is compared to the general model where the categories are separate. Like with the likelihood ratio Chi-square test, the two models are subtracted from each other to

produce a Chi-square and significance values, with statistical significance indicating that the general model improves the fit over the parallel lines model and suggesting the ordinal logistic regression approach does not fit the data. To evaluate the contribution of each individual predictor, the author adopted the *Wald Chi-square test*, the statistical significance of which indicates that the predictor under consideration is reliably associated with the dependent variable (Tabachnick & Fidell, 2013). Tabachnick & Fidell (2013) suggest that the size of a sample under study is as important as null hypothesis significance testing when validating the model. The main issue to consider is that large sample size is not necessarily good for logistic regression models as higher number of cases in the sample may produce significant results even when those have no practical importance.

Internal validity, according to Shadish et al. (2002) is concerned with whether the observed covariance between the independent variables and dependent variable reflects a causal relationship between these variables in the form in which they were set and measured and is closely related to the statistical conclusion validity. Thus, to ensure internal validity the researcher must show that the designed explanatory variables precede the dependent variables in time, that those variables covary as anticipated, and that there are no other feasible explanations to those relationships. In the case of this scientific inquiry, the survey instrument and all the variables were designed in accordance with the *Thematic Analysis findings*, and the causality of designed survey variables was derived from the interview participants' lines of speech. Statistical conclusion validity, the adopted rigorous approach to which ensures it is achieved in this quantitative inquiry, resolves another issue related to internal validity concerned with the covariation between the independent variables and dependent variables, as it proves the relationships between those are not accidental.

Construct validity is concerned with the understanding and assessment of constructs used in quantitative inquiry (Shadish et al., 2002), and estimates the degree to which the empirical indicators, or the attitudinal variables in the case of this quantitative inquiry, measure the construct through establishing unidimensionality and reliability of constructs (O'Leary-Kelly & Vokurka, 1998). Unidimensionality is concerned with determining whether a set of empirical indicators relates to one and only one construct and, thus, dealing with multicollinearity; the reliability is concerned with determining the degree of measurement error. *Exploratory Factor Analysis (EFE),* adopted to determine latent variables for the 40 attitudinal Likert-scale statements developed for this quantitative inquiry, is an established approach to ensuring *unidimensionality* of constructs. In EFA, however, the size of the sample also affects the results. A prevalent *rule-of-thumb* used by

researchers to determine the a priori factor analysis sample is 10:1, meaning there should be at least 10 subjects for any one empirical indicator (Costello & Osborne, 2005). The author took the latter into consideration when collecting the data, however, also used *Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy*, according to which the sample is adequate for EFA if the value of measure achieves a bare minimum of 0.5, and *Bartlett's Test of Sphericity* to indicate whether sample's scores on the attitudinal Likert-scale statements make the latter related to one another (Hadi et al., 2016). *The Cronbach α*, which represents the true score of a construct with values from 0 to 1 (O'Leary-Kelly & Vokurka, 1998), was the method adopted by the author for assessing *reliability.*

External validity is concerned with the generalisability of inferences to individuals, environments, and contexts outside of the experiment (Onwuegbuzie, 2000). As the aim with this quantitative inquiry was to discover, contextualise and relate the MaaS induced travel behavioural intentions of UK transport users, the inferences had to be to a degree generalisable from study's sample to the adult UK transport user population. For such generalisations, a probability, or in other words random, sample is generally considered of better use but is rarely feasible in quantitative experiments (Shadish et al., 2002). Neither for this scientific inquiry randomised selection of participants was feasible; thus, non-probability sampling approaches were used. According to Nikitas et al. (2018), identifying the profile of sample in terms of its demographic characteristics is a useful tool that facilitates more meaningful analytic comparisons and determines the potential of the sample to be representative of a wider population. Thus, to recognise, and to some extent even overcome, the *limitations of non-probability sampling* for survey research, some of the socio-demographic characteristics of the obtained sample, as suggested also by Wolf et al. (2016), were compared to official national statistics, such as 2011 United Kingdom Census data and the National Travel Survey data, in order to test for sample's representativeness of the studied population. Generalising the inferences to other contexts and environments could also be of interest as MaaS is a hyped phenomenon for researchers and policy makers across the world. Testing the applicability of this study's inferences to other contexts, given the time and the resources of the author, was unviable and accepted as this inquiry's limitation.

3.6. Conclusions

To fulfil the overall aim of this study an exploratory sequential mixed methods approach was selected by the author. The choice of methodology is justified by *thesis objectives*, *conceptual*

background, derived from the literature review, *pragmatic philosophical stance* of the author, and the desire to produce more *robust results*. This methodology is a unique combination of data collection and analysis techniques that has not been previously adopted in the MaaS research. So, at the qualitative phase of this research the data will be collected using individual semi-structured interviewing and analysed using Braun & Clarke's (2006) Thematic Analysis. The qualitative findings will then be used to inform the development of data collection instrument for the quantitative phase - online self-administered quantitative survey. The quantitative data will be analysed using a combination of statistical techniques, namely univariate analysis, exploratory factor analysis, and ordinal regression modelling. At both phases, the data will be collected and analysed following the explicit rigour strategies also specified in this chapter.

CHAPTER 4. QUALITATIVE PHASE AND ANALYSIS

4.1. Introduction

This chapter presents the key stages of the qualitative phase of this scientific inquiry. First, the development of an interviews guide is described. Then the interviewing process is reported. The obtained sample and its characteristics are also presented. The description of step-by-step analysis process and the overview of qualitative findings complete the section.

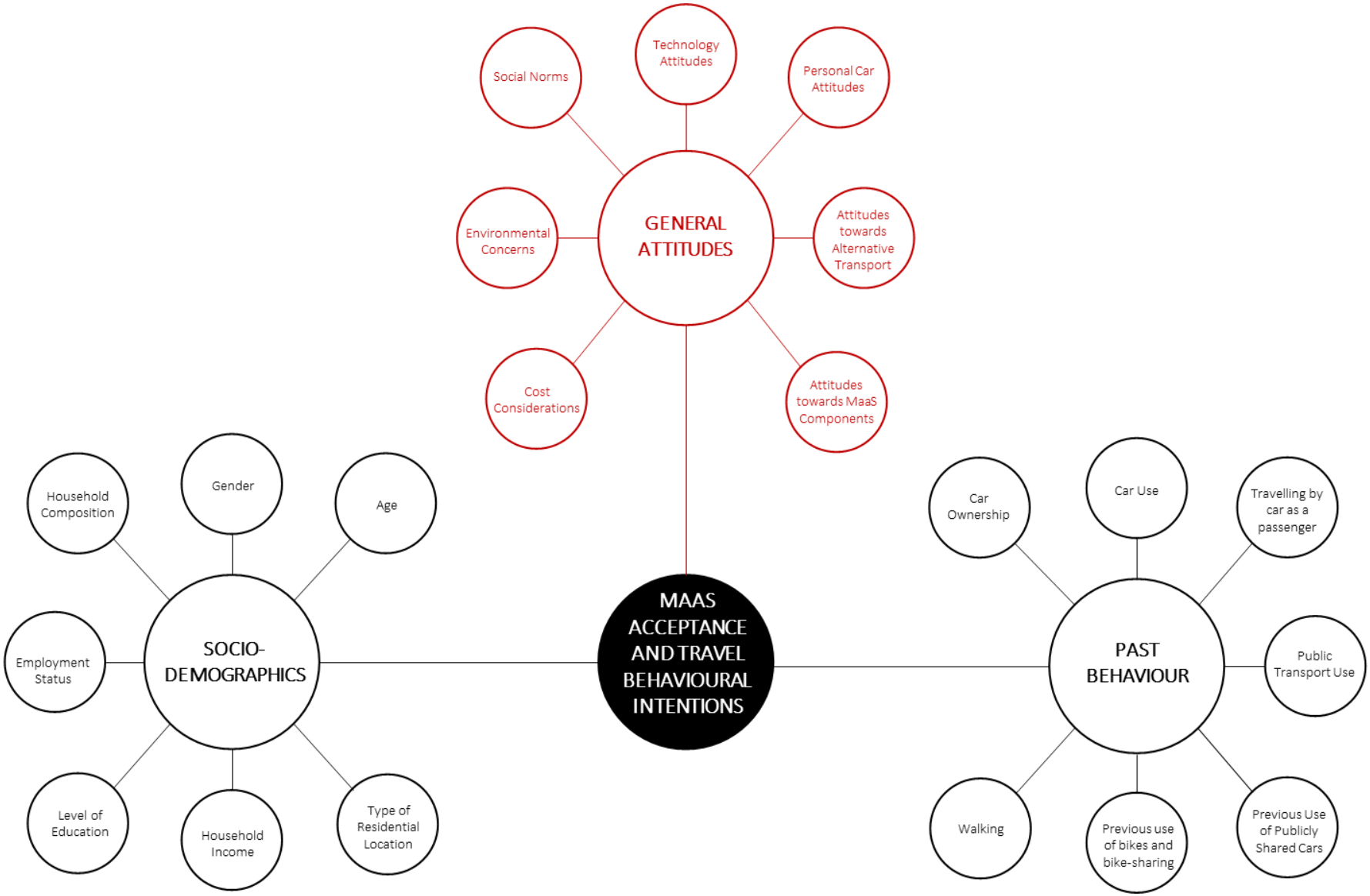
4.2. Interview Guide Development

When developing an interview guide, the author of this thesis, in accordance with suggestions by Bryman & Bell (2011), aimed to create a certain amount of order in the topic areas to cover and, thereby, ensure a good flow of questions. As mentioned previously, the developed interview guide was made of seven parts: individual demographics; attitudes towards private car use; attitudes towards the use of PT; attitudes towards other transport modes; other travel norms; familiarising with MaaS through an infographic; and attitudes towards MaaS. The demographic characteristics collected from participants included age; gender; marital and family status; availability of driving license; cars in the household; level of education; employment status; and household income after tax. The process of interview guide development and infographic design are presented further in this chapter section.

4.2.1. Theoretical Underpinnings of Topic Areas

This qualitative inquiry, although taking into consideration individual socio-demographics and past behaviour, has as its aim to explore the attitudinal factors that influence travel behavioural intentions with MaaS. Via literature review, attitudes towards personal car and alternative transport modes, but also attitudes towards technology and towards MaaS and its components were found to influence transport users' decision regarding the acceptance and use of MaaS. Moreover, the latter decision was also found to be influenced by individual social norms, environmental concerns, and cost considerations. Therefore, the interview guide was built with the aim to cover the above attitudes, working in line with the preliminary conceptual framework, presented on Figure 4.2.1, where the line of qualitative inquiry is highlighted in red. As mentioned previously, this qualitative inquiry also aimed to study MaaS travel behaviour only on a hypothetical level; therefore, these possible behaviours are regarded as intentions.

Figure 4.2.1: Applying Conceptual Framework - Qualitative Inquiry



The biggest concern behind the interview guide development, however, was composing the questions that would elicit those attitudes in the best possible way; thus, the author of this thesis referred to attitudinal theory. Retrieving and using previous knowledge, or existing theory, is one of the major steps in preparing a successful interview guide as it allows to gain adequate understanding of the subject and create a conceptual basis for the interview (Kallio et al., 2016). One of the attitudinal theories that recognises the role of intention, or individual's willingness to perform a specific behaviour, in behaviour formation is the Theory of Planned Behaviour (TPB). The attitudinal variables that in TPB influence the intention to behave in a certain way include the attitude itself, or the degree to which a person has a favourable or unfavourable appraisal of the behaviour in question (Ajzen, 1991), but also the subjective norm, or the perceived by an individual social influence to perform a given behaviour, and perceived behavioural control, or the perceived by an individual ease or difficulty of performing new behaviour. According to TPB, the attitude is formed by behavioural beliefs, or the considerations of the likely consequences of a behaviour in question, which then set an individual to perceive the given behaviour either as advantageous or not (Fishbein & Ajzen, 2010). Thus, to form the questions capturing interviewees' attitudes towards different transport modes as well as attitudes towards technology, MaaS, and its components, the author relied on guidelines from Fishbein & Ajzen (2010) for eliciting behavioural beliefs by asking about the advantages and disadvantages of transport mode use behaviours and travel app use behaviours as well as the potential use of MaaS itself.

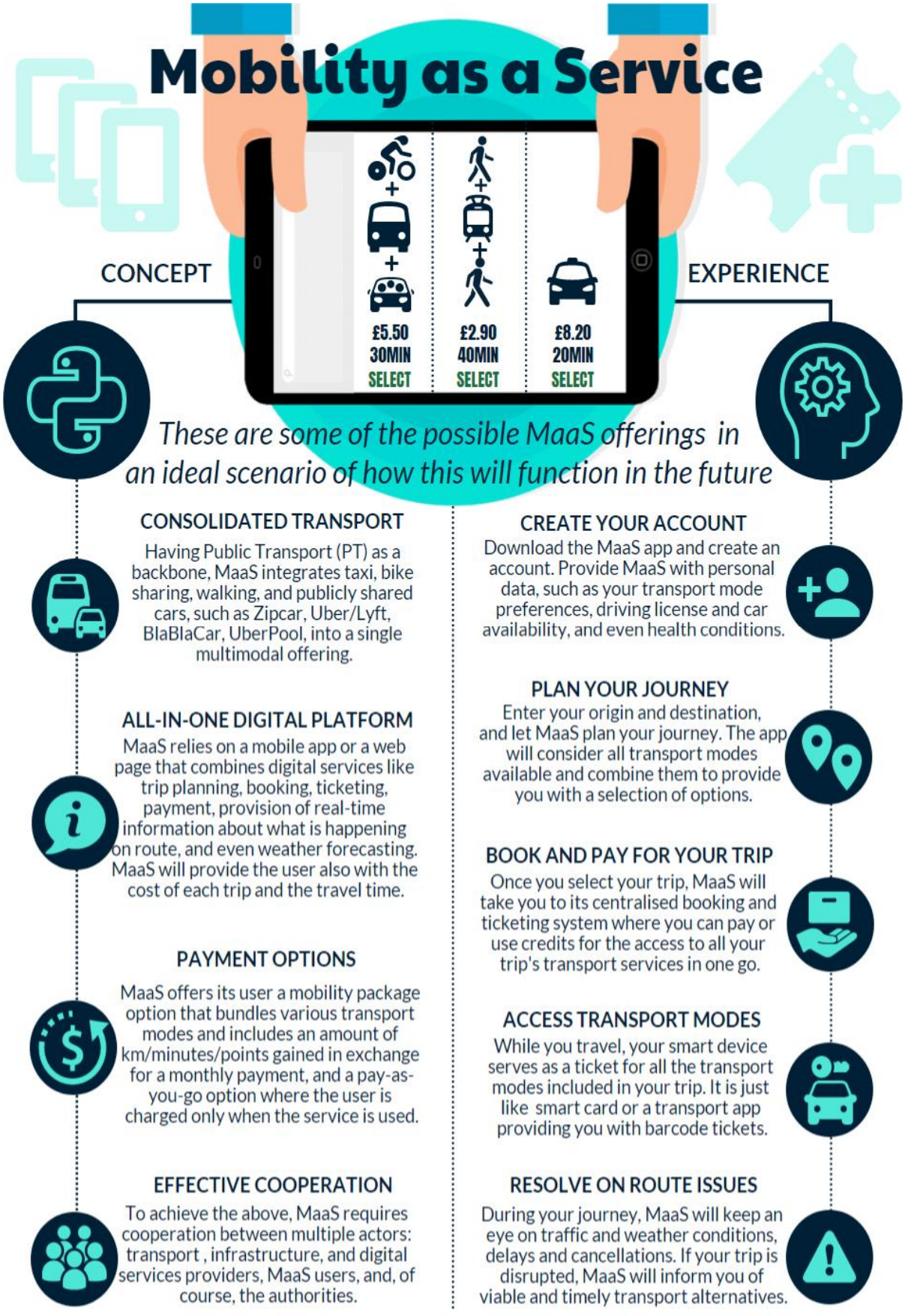
Subjective Norm, according to TPB, is formed by normative beliefs concerned with probability of important others to approve or disapprove of an individual performing a given behaviour. This construct is in a way similar to social norms driving MaaS acceptance and use and, thus, was used as a baseline for elicitation of attitudes. To elicit normative beliefs, in line with the guidelines by Fishbein & Ajzen (2010), the author of this thesis asked whether there were any individuals or groups of people who influenced interviewees' travel related decisions, and the ways in which the latter happened. Lastly, the PBC is influenced by control beliefs which are concerned with the presence of factors that make a behaviour either easy or difficult to perform (Ajzen, 1991). Although an alike construct did not become explicit via literature review, the author made the decision to ask interviewees questions concerning the above to possibly get a better understanding of the drivers behind MaaS acceptance and its travel behavioural implications. Following the mentioned above guidelines, to elicit control beliefs the author of the thesis asked the interviewees about circumstances that made the behaviours of interest easy or difficult to perform.

Another set of attitudes to elicit using the interview techniques was the environmental concerns of transport users. Several researchers argue that moral norm, the construct developed by Schwartz (1977) for explaining altruistic behaviours, or behaviours that promote the welfare of others, plays an important role in determining individuals' sustainable, especially with regards to environment, behaviours including travel mode choice (Bamberg & Schmidt, 2003; Donald et al., 2014; Hunecke et al., 2001; Steg & Vlek, 2009). In order to travel sustainably, an individual must be aware of how his potential behaviour affects the environment and realise that one is responsible for that effect. Moral Norm is particularly applicable to car use behaviours, as a moral obligation not to drive was found to have a negative association with car use and influenced the use of more sustainable transportation alternatives (Donald et al., 2014; Hoffman et al., 2017). Thus, the questions looking to elicit transport users' environmental concerns were based on the construct of Moral Norm but put alongside the questions eliciting attitudes towards personal car. It was expected, however, that, if present in transport users' individual choice models, those will be mentioned by them throughout the discussion. The last topic area that had to be covered in the interview guide was related to transport users' cost considerations when travelling with MaaS. Therefore, a question concerning transport users' expectations of what the cost of MaaS should be was integrated within the interview guide.

4.2.2. Designing the Infographic

A literature-infused infographic, presented on Figure 4.2.2, was developed adopting key MaaS characteristics as presented in Jittrapirom et al. (2017) and Mulley et al. (2017). The infographic contains textual conceptual description of MaaS as well as some graphic MaaS elements, i.e. a hypothetical app mock-up. Similar methods aiding data elicitation were previously applied in MaaS related research. For example, Schikofsky et al. (2020) used a conceptual description of MaaS to make focus groups participants aware of MaaS and its functionalities and enhanced conceptual description with MaaS app mock-ups to aid the data collection at the survey stage. Similarly, Fioreze et al. (2019) used conceptual description and MaaS app mock-ups to explain the concept to their survey participants. The author aimed to be value-neutral in the way MaaS was presented in the infographic. MaaS as a concept was explained using four conceptual features, each supplied with a brief description, namely: consolidated transport offering; all-in-one digital platform; payment options; and effective cooperation. In addition, the travel experience with MaaS was described as a five-step process of: creating account; planning the journey; booking and paying for travel; accessing transport modes; and resolving on-route issues.

Figure 4.2.2: MaaS Infographic



4.2.3. Piloting and the Final Interview Guide

The aim of piloting in interview guide development is to confirm the relevance of the content in the interview guide and to identify the possible need to make informed changes and adjustments to the interview questions and, thus, improve the quality of data collection (Kallio et al., 2016). So, in this qualitative inquiry the interviews were piloted using field testing technique, where real interview situation was simulated with potential study participants. To do the latter, the author of this thesis approached the employees and students at the University of Huddersfield, which resulted in a total of five pilot-interviews performed prior actual qualitative data collection. Although the initially developed set of questions did not require any changes except minor rewording, field testing helped make the questions in the interview guide more comprehendible and determine whether they truly elicited the potential participants' varying opinions. It also helped establish the time frame for each interview session and, consequently, make actual interviewees aware of the time to put aside to participate.

A full interview guide used for each interview session is presented on Figure 4.2.3. Thereby, after piloting, a total of 38 questions were composed for the interview guide, all divided into 7 topic areas. For the start, there were 7 questions asking for interviewees demographic characteristics. Questions 8 to 13 studied participants attitudes towards private car use, with questions 12 and 13 being theory driven, and others being the so-called follow-up questions, used for switching from topic to topic and for conversation development. Similar approach was taken for the topic area focusing on the use of public transport and the use of alternative to the two already discussed transport modes. Questions 14 and 15 focused on participants' moral norms in relation to car use, while questions 28 to 30 were eliciting beliefs related to subjective norms and PBC. Questions 35 and 37 had as their idea to determine what intentional behaviours participants were adopting and for what reasons, with the assumption the participants would at that point somehow reflect on what had been said by them previously. Question 34, as can be noted, asked about the cost of the service and its impact on decision to use MaaS. The decision to ask such question came from the review of the literature and the many empirical findings that cost is one of the major influences, alongside attitudes, on intentions to use MaaS.

Figure 4.2.3: Interview Guide

PART I: DEMOGRAPHIC CHARACTERISTICS

1. What is your date of birth?

2. What is your marital status? Are you single/in domestic partnership/married/divorced/etc.? How many children are in your household?

3. What is the highest degree or level of school you have completed? If currently enrolled, highest degree received.

4. What is your current status of employment (employed/self-employed/unemployed/student/ retired/etc.)? What is your job title?

5. What is your personal/household income?

6. Do you have a driving license?

7. Do you have your personal car (household car)?

PART II: ATTITUDES TOWARDS PRIVATE CAR USE

8. How often do you use your own car (either as a driver or as a passenger?)

9. Every time you decide to travel by car, do you compare it to other available options?

10. What is usually the purpose of the trips that you use your own car for?

11. Would it be difficult for you not to use your car for those trips?

12. What benefits of travelling by car do you consider when making your travel decisions?

13. Are there any drawbacks of the use of your own car which you consider when making your travel decisions?

14. Many people think that cars and their excessive use generate problems for society, the environment and even the economy. What do you think about that?

15. Do you feel responsible for the above? What actions are you taking to change that?

PART III: ATTITUDES TOWARDS USE OF PT

16. How often do you use PT as a travel mode?

17. What is the purpose of the trips you use PT for?

18. What do you consider beneficial about travelling by PT when making your travel decisions?

19. Are there any drawbacks of travelling by PT you consider when making your travel decisions?

PART IV: ATTITUDES TOWARDS OTHER TRANSPORT MODES

20. How often do you use Taxi or Uber as a travel mode? Why do/don't you use it?

21. What is the purpose of the trips you use Taxi/Uber for?

22. Do you usually use those transport modes as substitute for or in combination with other transport options?

23. What are the benefits of taxi travel, in your opinion? What are the drawbacks?

24. How do you feel about the smartphone app experience that services like Uber offer? How easy/how difficult do you find to use those?

25. What is your opinion on the use of active transportation, such as walking and cycling?

26. What do you think of sharing a ride with a friend/a stranger?

27. What is your opinion on car sharing schemes? Do you see any benefits/drawbacks in using those?

PART V: OTHER TRAVEL NORMS

28. What circumstances make it easy for you to travel the way you do at present?

29. What circumstances make it difficult for you to travel the way you do at present?

30. Are there any particular individuals or groups of people who influence your decisions regarding transport and travelling? In what way?

PART VI: INTRODUCING THE CONCEPT OF MAAS

Infographic exercise: go through definitions of MaaS, highlight its features and their functions, and describe the experience it offers to its users in detail.

PART VII: ATTITUDES TOWARDS MAAS

31. Would you be willing to use MaaS for your everyday travel? Why? Why not?

32. What are the opportunities of using MaaS for travel? What are the barriers to using MaaS, in your opinion?

33. What do you think about the technological aspects of MaaS, to wit the provision of travel related services and information through a single smartphone application? What are the benefits to you? What are the barriers?

34. To what extent your decision to use MaaS would depend on the cost of the service?

35. Could MaaS change the way you travel right now?

36. If people most important to you were in favour of using MaaS, would you be in favour of using MaaS yourself? What about the influences of general public?

37. Having MaaS, would you be willing to give up your personal car? Why do you feel so?

38. Is there anything transport providers and policy makers could add to MaaS that would help you switch from your car to other transport modes and help you depend on car less?

4.2. Recruitment and Interviewing Process

The interviewing process started with the search for participants: the call for participants, explaining the criteria for participation in the interview was advertised at the University of Huddersfield premises as well as via social media platforms such as LinkedIn, Facebook and Instagram. Then the participants either volunteered to take part in the study or suggested individuals fitting the criteria from their personal contacts. A total of 40 transport users based in the United Kingdom were interviewed. Thus, this study has significantly exceeded the recommendation by Saunders at al. (2016) that the non-probability sample size for semi-structured interviews should be between five and 25. This number of interviews also allowed for saturation to emerge. A total of 21 participants were recruited through self-selection by directly responding to the call for participants. These self-selected individuals recommended another 19 participants for the study, which is the essence of snowballing approach. The author, as mentioned in the methodology chapter, remained purposive when accepting the identified individuals for interview to ensure the diversity within sample.

The interviewing process took place between February and June 2019. Upon identification of participants, the interviewing process involved two stages: the pre-interview arrangements with participants and filling out the paperwork, and then the interview itself. So, prior the interview, identified study participants were contacted via e-mail and provided with a participant information sheet explaining the nature of the study, a consent form asking for permission to record, store, transcribe and use the interview output for academic and research purposes to fill in, and the MaaS infographic to familiarise with the concept already before the interview. In this pre-interview correspondence, the participants were also given an opportunity to select the convenient date and time for the interview as well their preferred means of communication: face-to-face, Skype or phone. As many as 26 study participants were interviewed face-to-face. Two study participants were interviewed via Skype, and another 12 participants were interviewed via phone. Each interview lasted between 35 and 75 minutes and was fully recorded to ensure accuracy of the insights given by each participant. During the interview, participants were given the time to read through the infographic and familiarise with the concept of MaaS in case they were not able to do so before the interview. Participants were also given an opportunity to ask questions regarding the MaaS concept in case something appeared ambiguous to them. As mentioned previously in this thesis, the interviews relied on the interview guide. The questions asked, however, did not implicitly conform to the interview guide outline: the author of this thesis, was asking questions

not included in the guide or adjusting and even missing out on some pre-defined questions as she followed the line of what had been said by the interviewee, which is a common practice during semi-structured interviewing (Bryman & Bell, 2011). Generally, though, all pre-defined topic areas were discussed, similar questions were asked, and alike wording was used from interview to interview, allowing for consistency between the sessions.

4.3. Qualitative Sample Characteristics

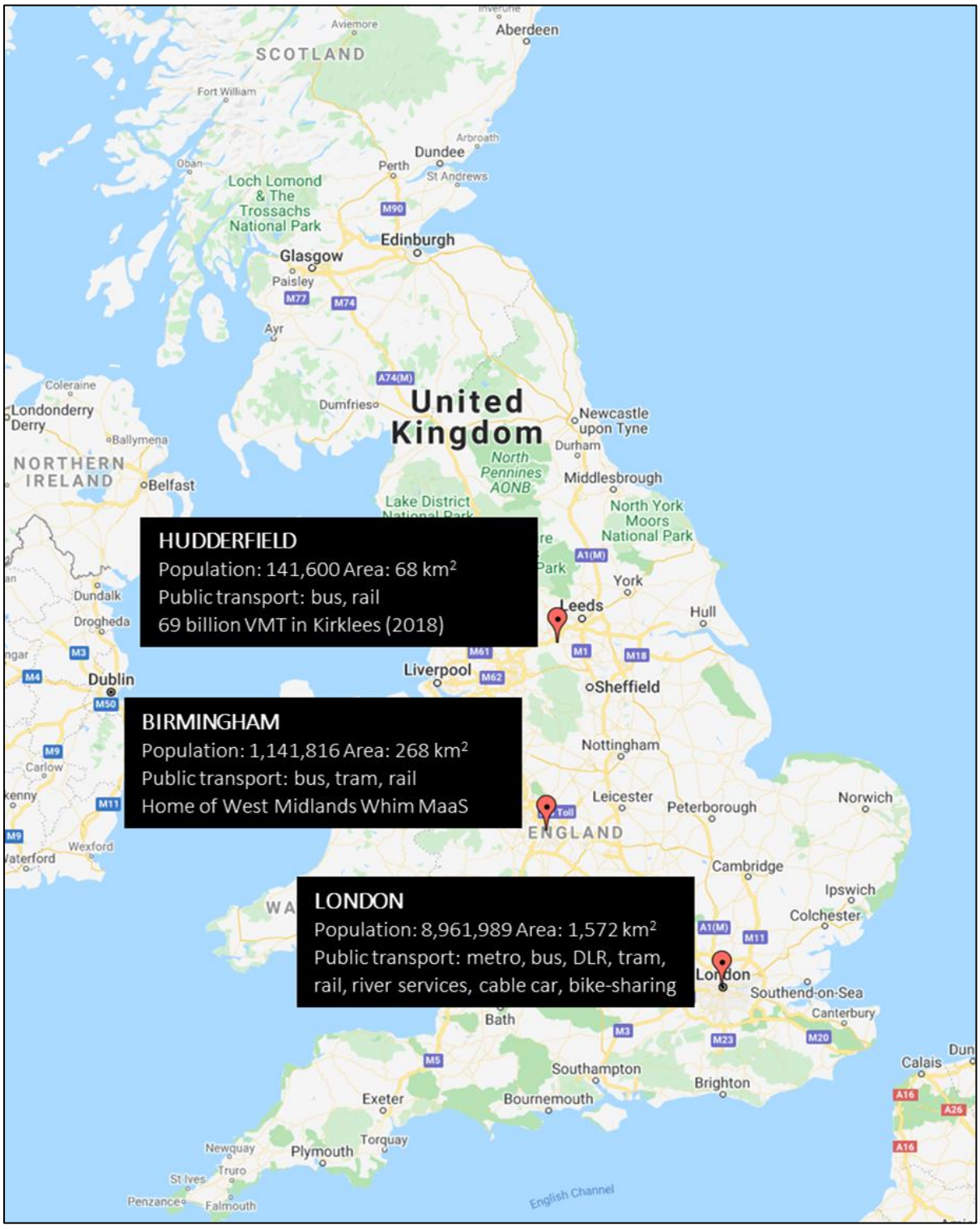
As previously mentioned, a total of 40 interviews with transport users based in the United Kingdom were conducted. The participants for this study were recruited from three geographical areas in the United Kingdom, namely London, Birmingham, and Huddersfield. With selected locations including a metropolis, a city and a town, this choice was also in a way purposive to facilitate capturing a diversity of transport users' views on MaaS and how these potentially align with key built environment specifics and urban planning considerations. A comprehensive outlook at the study locations as well as interview participants' demographic details are provided further in this section.

4.3.1. Study Locations

As mentioned previously, the participants for this study were recruited from the three locations, presented on Figure 4.3.1, namely London, Birmingham, and Huddersfield. With its population being close to 9 million in 2019 (Office for National Statistics, 2019) London is the largest city in the UK. Despite the highly developed transportation system in place and the introduction of congestion charging and Ultra Low Emission zone, London remains the most congested city in the UK with 227 hours lost in congestion per capita on annual basis (INRIX, 2018), and, also, one of the most car-centric cities with 2.66 million privately owned cars registered to its residents (Statista, 2020). Birmingham is the second largest British city by population with over a million inhabitants (Office for National Statistics, 2019), and the 12th most congested city in the country with 134 hours lost in congestion per capita in 2017 (INRIX, 2018). Birmingham is of particular interest to this study because it currently serves as a pilot ground for Whim app, the most well-known active MaaS scheme, the interest in which, however, has been poor, as evident from the Literature Review. Huddersfield is Kirklees' biggest town, with close to 150,000 inhabitants (Kirklees Council, 2018) and is home to the fourth most congested transport corridor in the United Kingdom outside London, the Huddersfield Road (INRIX, 2018). So, located in the South, the Midlands and the North

of England, these geographical locations differ significantly in size and transport system composition, offering a study cohort that includes a metropolis, a city and a town, all suffering from high levels of congestion, largely influenced by their residents' car-centric behaviours.

Figure 4.3.1: Qualitative Study Locations
Adapted from Google Maps



4.3.2. Demographic Profile

Table 4.3.1 lists the key characteristics of the participants providing their demographic information, and the presence of car within household. This information about participants was collected not with the aim of integration in the consequent analysis, but, at this stage, to clearly present the diversity in the sample. Participant ID consists of the location identifier (L for London, B for Birmingham, and H for Huddersfield) and the assigned participant number. Thereby, this qualitative study is based on interviews with 40 road users, living in the United Kingdom: 14 from London, 12 from Birmingham, and another 14 from Huddersfield. There was a moderate gender imbalance as the number of male interview participants exceeded the number of female participants by 14; this is acknowledged as a limitation of this study. The age of participants ranged from 19 to 64 years old. The participants also had varying levels of education, from secondary school education to doctorate degrees, and employment status, that being either student, employed full-time (FT), or employed part-time (PT). The approximate monthly household income of participants after tax ranged from £1,000 to £6,500. The study largely focused on car-owners, with 35 car-owning individuals participating, though, five members of non-car-owning households also took part for enabling a better identification of possible unsustainable side-effects referring to people that may actually see MaaS as an opportunity to access publicly shared cars on a more frequent basis. Thereby, through achieving a truly diverse sample that is sufficient in size and also saturated, the author fulfilled the *appropriate sampling* verification strategy requirements for insuring rigour of the qualitative research.

Table 4.3.1: Qualitative Sample Characteristics

ID	GENDER	AGE	MARITAL STATUS	CHILDREN	DRIVING LICENSE	CAR QTY	EDUCATION	EMPLOYMENT STATUS	HOUSEHOLD INCOME (MONTHLY)
L01	Male	28	Single	None	Yes	None	Master's	Employed FT	£3,200
L02	Male	50	Married	2	Yes	1	Bachelor's	Employed FT	£5,500
L03	Male	48	Domestic Partnership	5	Yes	4	Secondary	Employed FT	£4,600
L04	Male	35	Domestic Partnership	None	Yes	1	Bachelor's	Employed FT	£6,500
L05	Female	39	Domestic Partnership	1	Yes	2	Master's	Employed FT	£6,500
L06	Female	36	Married	None	No	1	Secondary	Employed FT	£4,600
L07	Female	28	Single	None	Yes	1	Master's	Employed FT	£1,800
L08	Male	53	Single	None	Yes	1	Bachelor's	Employed FT	£3,600
L09	Male	31	Domestic Partnership	None	Yes	1	Master's	Employed FT	£3,200
L10	Female	34	Married	None	Yes	2	Secondary	Employed FT	£6,500
L11	Male	35	Married	2	Yes	1	Master's	Employed FT	£5,000
L12	Male	48	Married	2	Yes	1	Secondary	Employed FT	£5,500
L13	Male	27	Domestic Partnership	None	Yes	None	Master's	Employed FT	£6,500
L14	Male	28	Single	None	Yes	1	Master's	Employed FT	£3,200
B01	Female	27	Domestic Partnership	None	Yes	1	Secondary	Employed FT	£1,500
B02	Male	64	Married	2	Yes	1	Secondary	Employed FT	£1,300
B03	Male	32	Single	None	Yes	None	Doctorate	Employed PT	£2,000
B04	Male	29	Single	None	Yes	None	Doctorate	Employed FT	£2,300
B05	Male	27	Single	None	Yes	1	Secondary	Employed FT	£3,800
B06	Female	24	Single	None	Yes	1	Master's	Employed FT	£2,000
B07	Female	29	Domestic Partnership	None	Yes	1	Bachelor's	Employed FT	£3,400
B08	Male	36	Married	2	Yes	1	Doctorate	Employed FT	£2,600
B09	Male	39	Single	None	Yes	None	Master's	Employed FT	£2,600
B10	Female	34	Married	3	Yes	2	Master's	Student	£5,000
B11	Male	36	Married	3	Yes	1	Bachelor's	Employed FT	£2,600
B12	Male	20	Single	None	Yes	1	Secondary	Student	£1,000
H01	Female	26	Married	1	No	1	Master's	Student	£1,900
H02	Female	36	Married	2	No	1	Doctorate	Employed FT	£3,000
H03	Female	51	Married	2	Yes	2	Master's	Employed FT	£3,000
H04	Female	53	Domestic Partnership	None	Yes	2	Doctorate	Employed FT	£3,000
H05	Male	24	Single	None	Yes	1	Secondary	Student	£1,000
H06	Male	29	Single	None	Yes	3	Master's	Employed FT	£8,000
H07	Male	56	Single	5	Yes	1	Secondary	Student	£1,000
H08	Male	41	Married	1	Yes	1	Master's	Employed PT	£2,000
H09	Male	28	Married	None	Yes	1	Master's	Employed FT	£2,000
H10	Male	25	Married	1	Yes	1	Master's	Employed FT	£1,900
H11	Female	25	Domestic Partnership	None	Yes	1	Bachelor's	Employed PT	£1,000
H12	Male	19	Single	None	Yes	1	Secondary	Student	£1,000
H13	Male	24	Domestic Partnership	1	Yes	1	Master's	Student	£1,500
H14	Male	36	Married	2	Yes	1	Doctorate	Employed FT	£3,000

4.4. Thematic Analysis Process

The interviews were conducted, transcribed, and analysed by the author of this thesis: no external agencies or organisations were involved in the process. The analysis procedure went in accordance with the selected as a method of analysis Braun and Clarke's (2006) Thematic Analysis, the procedure for which was described in detail in Chapter 3, Section 3.4.3.

Although the interviews were semi-structured and the interview guide was inspired by author's previous knowledge and theoretical considerations, the coding and theme identification processes in this analysis were data-driven, with the author focusing solely on the research objective and putting her theoretical formulations (i.e. the findings of the literature review) aside, to lessen *analyst-oriented biases* (Morse, 2015) and work in accordance with *theory development* strategy for ensuring rigour (Morse et al., 2002). Thus, the identified key themes and their sub-themes were linked to the theoretical literature upon completion of the analysis and not prior, which explains the occurrence of sources, not highlighted during the literature review process, within discussion (Chapter 6) and conclusion (Chapter 7). The coding process was initiated already at the data collection stage: the author paid careful attention to what had been said by each interviewee, with every new interview bringing new data to the table and making it clearer for the author what themes were likely to emerge. This was another strategy for ensuring rigour fulfilled by the author, with *data collection and analysis* carried out *concurrently*, and with the *theoretical thinking* involved in the analysis process (Morse et al., 2002). The author also fully recorded and transcribed each interview.

Notwithstanding the access to computer-assisted qualitative data analysis software (i.e. NVivo), the author made a choice of performing further steps of analysis manually. Thereby, full-scale coding process was carried out through repeated reading of and making notes on printed interview transcripts. Therefore, every one of the 40 transcripts were fully coded, with some data extracts, or, in other words, interviewee quotes, falling under more than one code. Next, an Excel spreadsheet was created for organising the codes and matching data extracts, with surrounding data kept in order to maintain the context, into a manageable format for theme identification. The codes, and the related extracts, were then scrutinised and combined to form overarching themes repeatedly to ensure that the final thematic map thoroughly meets the research aims of the study and fulfils the relevant research objective. It is important to note that the themes were not built only by looking for the wealth of textual evidence but, as also approached by Nikitas et al. (2019)

following the recommendations of Musselwhite (2006), by evaluating the dynamics of issues, highlighted by the interview participants, and identifying structures within the data that had an explanatory capacity in relation to the research objective.

During the theme identification process, it became obvious that, although some extracts belong to the same theme, they interpret different, and at times contradicting, theme dimensions. Moreover, as on occasion the extracts matched more than one theme, some of the themes also appear logically interlinked. There were also a few cases where two different sub-themes both discussed a specific agenda from an entirely different angle using quotes that might represent two entirely different viewpoints. Braun & Clarke (2006) suggest that the themes and relationships among them do not have to smooth out or ignore but instead retain the tensions and inconsistencies within and across data, which this analysis has conformed to, thus also fulfilling the *negative cases analysis* strategy (Morse, 2015) for ensuring validity of findings. When writing up the analysis results, the main considerations were to provide "a concise, coherent, logical, non-repetitive and interesting account of the story the data tell" (Braun and Clarke, 2006) and to demonstrate prevalence of the themes by selecting the most characteristic and convincing individual responses (Nikitas et al., 2018; Vaismoradi et al., 2013), which in its turn ensured *thick description* (Morse, 2015) of findings.

4.5. Overview of Findings

There is a very diverse range of potential travel behaviour changes that MaaS could induce. Some of this study's participants demonstrated intentions not to own a car if MaaS became available to them and functioned well; others were inclined to still depend on car by either giving preference to transport modes like taxi, carsharing and ride-sharing, or using their own car as well as using MaaS. MaaS is generally viewed as a complement to private car, and considered a more suitable option for trips, where participants are already accustomed to using transport modes other than the private car. These varying decisions were found to be influenced by five key factors: Car Dependence; Trust; Human Element Externalities; Value; and Cost. These five driving factors comprise the Thematic Map that resulted from the Thematic Analysis process and is in a way a theoretical model of behavioural intention formation with MaaS. More details on MaaS' behavioural intentional implications, as well as the description of a Thematic Map, and a discussion of developed themes will be presented in the sections below. These detailed findings of the qualitative stage are presented in a form of a narrative with evidence, which captures the essence

of the point demonstrated in the narrative, supplied as raw data extracts. These selected data extracts are presented in italics so that they can be easily separated from the analysis commentary.

4.5.1. MaaS and Travel Behavioural Intentions

None of the study participants had previous knowledge about MaaS, yet, the majority had used various travel apps, and therefore, when reading through the speculative infographic, easily comprehended the nature of the concept. Attitudes towards MaaS were largely positive with study participants willing to accept, or at least to consider using MaaS for travel once it is available on the market:

> *"I think MaaS is a good idea, and I would use it."* – B06, Female, 24, Licensed Driver, Primary Household Car Owner

> *"I like the concept of it, though. I think it's a good idea."* – L09, Male, 31, Licensed Driver, Primary Household Car Owner

> *"As a concept MaaS sounds very good. From my experience of using Uber and National Rail app, other than an odd quirk of the system, generally they're a good thing, and I quite like the idea."* – L12, Male, 48, Licensed Driver, Primary Household Car Owner

Indisputably, MaaS showed the potential to induce considerations of changes in travel behaviour among study participants. Some individuals, after familiarising with possible features that MaaS could offer, assumed they would no longer need to own a car:

> *"I would consider giving up my car, that is for sure. MaaS could eliminate the need for car."* – L14, Male, 28, Licensed Driver, Primary Household Car Owner

> *"If MaaS is as good as it says and my personal time isn't impacted greatly, then it makes sense, and I don't really need a car."* – L02, Male, 50, Licensed Driver, Primary Household Car Owner

> *"I think I would give up my car at some point if MaaS was convenient enough, because for longer journeys then you sort of could use carsharing."* – H04, Female, 53, Licensed Driver, Primary Household Car Owner

Non-car-owning individuals demonstrated how MaaS could reduce their reliance on car-based modes of transport and, thus, take their travel behavioural practices in a more sustainable direction:

"If, for example, I'm taking the train that arrives at a particular point at a particular time, perhaps, rather than taking a cab from that place I would take a bus if MaaS also told me that this bus was available at the time of my arrival." – B03, Male, 32, Licensed Driver, Non-Car-Owning

Others, although accepting the possibility to change the way they travel and to reduce the use of personal car, pulled out quasi-sustainable behaviours by showing great interest in relying on car based shared use mobility modes of transport, such as carsharing, taxi and ride-sharing, and generally refusing to use public transport:

"If MaaS was there and it was working smoothly, I would probably use car less. I would definitely try and use MaaS more. I guess I'd use more taxis and possibly carsharing. I never used carsharing before, but I would try that. Ride-sharing maybe not as much, but carsharing yeah!" – L03, Male, 48, Licensed Driver, Primary Household Car Owner

"If MaaS just offered me a taxi, that would be fine, or carsharing and ride-sharing. I don't think I would use any of the other options." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

"To be honest, if I could use those ZipCars, for example, I would much rather do that than have a car myself." – L07, Female, 28, Licensed Driver, Member of Car-Owning Household

"If I can get a car for some fixed payment each time I'm going out, I will do it, I will sell my car the next day. If I can get the car whenever I want it, if I come out on my street and "Hop!" the car is there, and nobody is using it at that moment, then yeah." – L11, Male, 35, Licensed Driver, Primary Household Car Owner

"I probably could use MaaS, and it would certainly be easy for me to pick up on things like carsharing. And that is what I think I would mainly use." – H03, Female, 51, Licensed Driver, Primary Household Car Owner

Some participants, even those currently not owning a car, took a stance where their decision to own and use a car could not be influenced altogether:

"I and a lot of people would not hold back from buying a car, no matter what alternative is presented." – B04, Male, 29, Licensed Driver, Non-Car-Owning

"All things being equal, if my health is okay, and I am not banned from driving, for me MaaS would be a no." – B11, Male, 36, Licensed Driver, Primary Household Car Owner

"You can have all the mobility with public and private transport in the world, but you still would need your car." – H11, Female, 25, Licensed Driver, Primary Household Car Owner

Nevertheless, while MaaS did not seem to be able to fully substitute private car use and car ownership for every individual, it was thought of as a "nice option" for occasional private car substitution:

"MaaS is a nice option to have." - L09, Male, 31, Licensed Driver, Primary Household Car Owner

"I would be interested in using this as well as having my own car." – B07, Female, 29, Licensed Driver, Primary Household Car Owner

"I would probably reduce the number of times I use my car." – H07, Male, 56, Licensed Driver, Primary Household Car Owner

"I wouldn't abandon my car, but I could split, and for some journeys I would still use my car, and for other journeys I would use MaaS instead." – H08, Male, 41, Licensed Driver, Primary Household Car Owner

4.5.2. Presenting the Thematic Map

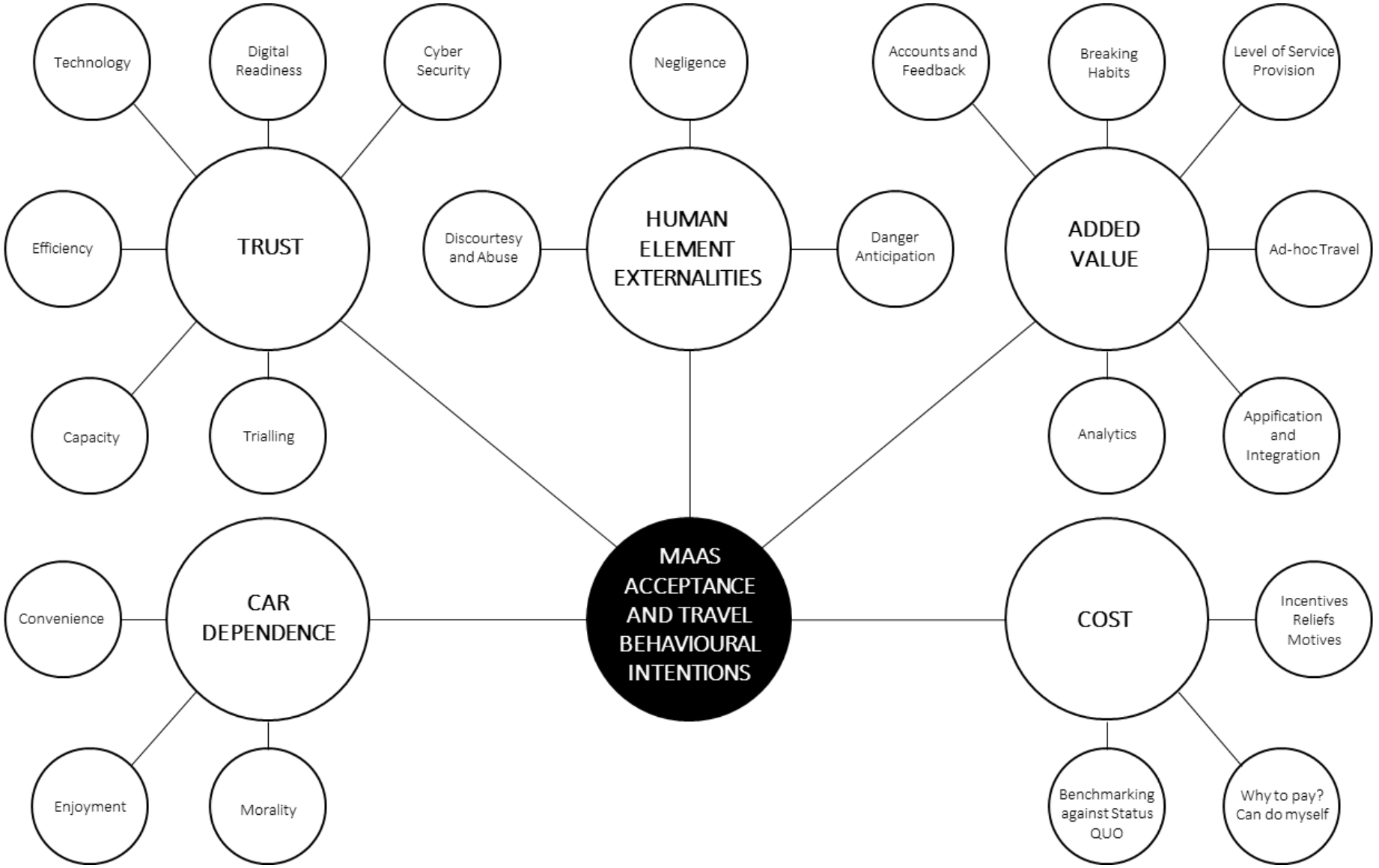
This analysis identified five core factors, or in the case of this scientific inquiry themes, as critical determinants underpinning transport users' travel behavioural intentions with MaaS: Car Dependence; Trust; Human Element Externalities; Added Value; and Cost. Each of the themes has distinctive dimensions, expressed as their sub-themes as presented on the developed via Thematic Analysis Thematic Map on Figure 4.4.1.

Thus, this study's finding suggest that the transport users still show a great deal of Car Dependence, due to the *convenience* and *enjoyment* of car ownership and use, thereby retaining unsustainable travel behavioural patterns. This work has also identified the aspects of individual *morality* concerning environment and sustainability as a strong influence on switching to sustainable MaaS based travel. Moreover, there were a number of Trust issues the concept had faced. Participants talked about the need of *trialling* the tool, their concerns with *efficiency* of digital services coming

through MaaS, the transport *capacity* on offer, overreliance on *technology* and mobile devices, *cyber-security* behind MaaS system, and the *digital readiness* of individuals to access transport via digital platforms. Another aspect explored by this analysis is the impact of Human Element Externalities on the sustainable uptake of MaaS. *Negligence* of transport providers appeared to be one of the biggest concerns of transport users when it came to using alternative to personal car shared means of transport. It was also the high risks of experiencing *discourtesy and abuse* from fellow travellers that made study participants *anticipate danger* and thus feel reluctant about travelling on public means of transport with MaaS.

This analysis also thoroughly discusses what transport users considered the aspects of Added Value when shifting to MaaS based travel. The *appification* of MaaS was regarded as a primary feature of value as seeing all available in a given area transportation *integrated* with supporting services could make travel by shared means of transport more convenient and accessible. The all-in-one service could *break existing travel habits* by offering the user more sustainable travel modes. The ability to *create accounts and give feedback* to drivers and fellow travellers could make sharing transport more transparent. It was also recognised that MaaS could perform *analytics* in a way that would help eliminate the network capacity bottlenecks. Although some participants considered using MaaS for regular travel, like their daily commute, the majority viewed MaaS as a tool for organising *ad-hoc travel*, such as occasional long-distance trips and trips with the purpose of tourism. The *level of service provision*, as it is as present, is far from being able to seamlessly serve user needs, which is, though, essential in inducing a positive change in travel behaviour on more than just occasional basis. Participants' views on what the Cost of travel by alternatives to personal car with MaaS should become made it clear that travel by alternatives is still considered inferior to car use. Although valuing some of the features MaaS may offer, only a few study participants wished to pay extra for the MaaS service, this way *benchmarking against status QUO* and demonstrating a *Why to pay? Can do myself* attitude. The majority wished to be *incentivised* to use the service, either by making savings on travel, getting bonus points via app, or even through government enforcement.

Figure 4.5.1: Thematic Map



Theme One: Car Dependence

The first key theme that emerged from the analysis was Car Dependence. This theme looks into the aspects that form participants' bonds with cars and how those influence their attitudes towards MaaS, and the associated travel behaviour change considerations. What this theme is also trying to highlight is that the interview participants in some cases were not structurally car dependent, yet they exhibited strong preferences for the use of cars for a number of reasons. The theme is particularly important as, generally, participants viewed MaaS and the possibility of extensively relying on it for their travel needs through the lens of owning and using a car:

> *"I think a lot of people get used to the comfort of cars, and it is very difficult to change this. Now that I don't have my own car, I would absolutely use MaaS."* – B01, Female, 27, Licensed Driver, Member of Car-Owning Household

The analysis of the theme enabled the researcher to also identify three main expressions, or sub-themes, of Car Dependence. So, Car Dependence was expressed through ***convenience*** of using and owning a car, ***enjoyment*** of cars and the driving process, and also the concept of individual ***morality*** focusing on participants' environmental concerns related to car use.

Convenience

The notion of a car being a far more convenient transport option when compared to any other transport mode is not new. In the same way, the participants of this study have almost unanimously demonstrated the perceptions of MaaS not being able to replicate the convenience of a car:

> *"If with MaaS I didn't have a car, it would be just really inconvenient for me."* – H13, Male, 24, Licensed Driver, Primary Household Car Owner

> *"MaaS will not change my mind from driving because it doesn't resolve all the issues that push me to drive."* – B03, Male, 32, Licensed Driver, Non-Car-Owning

> *"I could probably survive without the car, but it would be difficult."* – L05, Female, 39, Licensed Driver, Primary Household Car Owner

There were specific features the participants referred to when defining the convenience of using a car for travel as opposed to travelling with MaaS. First and foremost, participants expressed their worries regarding unpredictability of time the journey would take if it were not done by car:

> *"If you take the bus or the train, you can get longer waiting times or delays that you're not in control of, compared to when you're driving your car."* – L06, Female, 36, Non-Driver, Member of Car-Owning Household

Participants also brought to the table their financial considerations, discussing how, in many situations, using a car would be the most cost-effective way of travelling for them:

> *"If it was as a daily commute, I'm not sure you could make MaaS cheap enough to convince me. I'd rather just get in my car."* – H06, Male, 29, Licensed Driver, Primary Household Car Owner

> *"I can use my car exactly when I want to go, at a price that I can afford and am prepared to pay."* – L12, Male, 48, Licensed Driver, Primary Household Car Owner

Participants agreed that there was little consideration within MaaS system for travel with luggage and other heavy items, thus private car was still considered the most convenient transport option for trips with such purpose:

> *"If I had any luggage, it's just a matter of moving it from home straight into the car, and it's all part of convenience."* – B11, Male, 36, Licensed Driver, Primary Household Car Owner

> *"Yesterday I went to get my son from university accommodation, and I couldn't do that without my car because we had to bring his suitcases home. I couldn't do it with MaaS yesterday. You couldn't do it when you got lots of luggage to carry."* – B02, Male, 64, Licensed Driver, Primary Household Car Owner

> *"If I decide to go and buy some wood or some bags of cement, I'm probably not going to carry them on a train, so I need a car for that."* – L04, Male, 35, Licensed Driver, Primary Household Car Owner

Independence from public transport and the ability to overcome constraints associated with schedule and infrastructure, which could still exist in the MaaS era, were other important aspects adding to the convenience of using a car as opposed to MaaS:

"With my car I can plan my own trip when I want it, so I don't depend on any other time constraints from other transport means." – H10, Male, 25, Licensed Driver, Primary Household Car Owner

"You know, with my car I'm not restricted to the timetables of trains, for example, and places where I can go. I get more choice." – H09, Male, 28, Licensed Driver, Primary Household Car Owner

By some study participants a car was considered the only transport option that would allow avoiding harsh weather conditions:

"I go pretty much everywhere by car with my boyfriend, so it doesn't really matter to me whether it's rainy or foggy. Whatever problem could possibly be there, I have a perfect solution." – B01, Female, 27, Licensed Driver, Member of Car-Owning Household

"Sometimes you do need to drive, if it's raining, for example." – B07, Female, 29, Licensed Driver, Primary Household Car Owner

Strong opinions on the convenience of car were also enhanced by participants' perceptions of it being a lot safer than the other means of transport offered by MaaS:

"Even if you're not in your own vehicle, but, for example, in a taxi, you are on your own. Late at night public transport could be quite a special experience." – L09, Male, 31, Licensed Driver, Primary Household Car Owner

"Compared to public transport and other modes, car is a lot safer" – B12, Male, 20, Licensed Driver, Member of Car-Owning Household

Many participants felt as if the private car was the most convenient and readily accessible transport option also for cases of emergency and disruption:

"If there was an emergency, whatever that might be, a trip to a hospital or going to see someone quickly, you've got your own car, you can drop everything and go, whereas with MaaS there is always going to be a lag." – L09, Male, 31, Licensed Driver, Primary Household Car Owner

"It probably sounds really stupid, but I like knowing that the car is there if it's an emergency." – L10, Female, 34, Licensed Driver, Primary Household Car Owner

"You should never be solely reliant on one application. I've got a car, and if it breaks down, I can get a train and I can get a taxi. But because either of those are good or my car is good, I wouldn't completely get rid of the other option. I'd always keep a backup for cases of emergency." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

"You want your car in case of emergency, and I wouldn't rely on MaaS for emergency. If I had to take someone to the hospital, say, Sunday night at 10 o'clock, I wouldn't rely on a bike share or on a carshare for that. Also, even with MaaS, from the time you order the service you would have to wait, and in case of emergency you need that transport outside your door straight away." – H14, Male, 36, Licensed Driver, Primary Household car Owner

When compared to MaaS, car was also viewed as a more convenient and comfortable transport option for family travel:

"I think the convenience and the comfort for my family is more important here. For that, I would not want to swap my personal car for MaaS." – B08, Male, 36, Licensed Driver, Primary Household Car Owner

"It's the fact that I've chosen my car because it suits my family's needs." – L12, Male, 48, Licensed Driver, Primary Household Car Owner

Enjoyment

The car came across as a preferred transport option not only because of the convenience but also because of the general enjoyment of its ownership and use:

"I like my car, and it is fun. Would you give up your shoes if you were offered a pair of sandals?" – B05, Male, 27, Licensed Driver, Primary Household Car Owner

For many study participants driving a car was far more than just the means for getting from A to B. They spoke about how the driving process was enjoyable, rewarding and strengthened self-esteem, and the other pleasures that came along with driving:

"It is also self-esteem to some extent because if you're driving a car, if you are satisfied with the car, if you drive the car you really like, that becomes the point of it. That's

what we are looking for in our life. It's a way of treating ourselves." – H08, Male, 41, Licensed Driver, Primary Household Car Owner

"I just got my car in January so it's like my little baby at the moment, and I love it. I just passed my driving test, and it's a big success because I just passed, and I'm like "Well done me!" for driving my car more than anything else." – B06, Female, 24, Licensed Driver, Primary Household Car Owner

"I enjoy driving because of the comfort of driving and because I love driving. I'm so happy when I drive, I'm so comfortable. The comfort, the pleasure of seeing and learning new places, they tend to make me want to drive most of the time wherever I'm going." – H07, Male, 56, Licensed Driver, Primary Household Car Owner

Another point made by the study participants referred to the enjoyment of privacy and personal space that the car allowed its user to have:

"I've had a car since I was 17 and when I drive I feel like it is a "me-time"; I'd put my music on and go into my own little world." – L10, Female, 34, Licensed Driver, Primary Household Car owner

"Well, I just enjoy driving. That's the big thing for me. I like the peace and quiet, the personal space, that time to reflect on my day before or after work, which is quite nice." – H03, Female, 51, Licensed Driver, Primary Household Car Owner

"The car is all my own environment, so I can turn on my Radio1 and relax more. You know, I've got my personal little bit of space." – B02, Male, 64, Licensed Driver, Primary Household Car Owner

The enjoyment of owning a car, or, as said by the study participants, "having your own thing", was another aspect that increased participants' car dependence:

"People feel secure when they have their own stuff, and having a car is having your own thing. You would prefer that and the benefits it brings any time of the day." – B04, Male, 29, Licensed Driver, Non-Car-Owning

"I'd say a car is probably a luxury where we live, but we like having it." – L09, Male, 31, Licensed Driver, Primary Household Car Owner

"I aspire to having a car. When I think about it, I actually wouldn't have anything to do with it. It would be for fun; it would be a toy." – L01, Male, 28, Licensed Driver, Non-Car-Owning

The enjoyment of owning a car, as discussed by the study participants, also emerged from the fact that they needed to follow the car ownership "trend" to better fit into society:

"I generally enjoy cars. From a linear point of view, you can view cars as plainly the use of transport, but they can be for enjoyment, they can be for general social aspects. And I think with a car, you have that bit of a trend, where people have cars, your friends have cars, and that would probably have an impact on why I would have a car." – L13, Male, 27, Licensed Driver, Non-Car-Owning

"In my family everybody has got a car, so it would be quite weird if I didn't have one." – H13, Male, 24, Licensed Driver, Primary Household Car Owner

Morality

The context of morality also showed potential to have an impact on transport users' car dependence. Sustainability indifference and misinterpretation of the impacts of car use on society and environment were yet another explanation to the pursuit of driving habits:

"Whilst I am very aware that there is a problem, it's not a big enough problem for me to say that I'm not going to use my car anymore." – L10, Female, 34, Licensed Driver, Primary Household Car owner

"If everyone uses a car that is environmentally safe in terms of emissions it produces, like I do, then we would have a safer environment. So, on my part I know that I use something environmentally friendly." – B11, Male, 36, Licensed Driver, Primary Household Car Owner

"If I cause emissions or something, that wouldn't make any difference to me. My car wouldn't make that much difference if I stopped driving. There are a lot more things that impact the environment, more than the car, so I would still drive. Unfortunately, I still throw plastic bags away and buy them every time I'm shopping, so my car is the least of my worries." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

Some participants demonstrated how becoming concerned with the environment and sustainability made them, to some extent, uncomfortable when choosing to drive, thus causing cognitive dissonance:

> *"Recently the British government announced that diesel cars are rather dangerous, and because I've got one, that makes me a bit uncomfortable."* – H08, Male, 41, Licensed Driver, Primary Household car Owner

> *"I'm challenged quite often because I do have an interest in sustainability, but I also like to drive."* – H03, Female, 51, Licensed Driver, Primary Household Car Owner

Others brought up the examples of how sustainability concerns have already made them shift their travel practices towards sharing their cars or even away from private car use on some occasions:

> *"I have concerns about the environment. I travel to work via train and so does my husband, so we keep our fuel emissions from the car to a minimum. We only use the car on the weekends. I feel like we do our part and we're not really using it excessively like most people would."* – L06, Female, 36, Non-Driver, Member of Car-Owning Household

> *"Cars are noisy, and pollutants are smelly. It's not ideal. On that, I try to cycle in cities, or walk, or use public transport."* – H05, Male, 24, Licensed Driver, Primary Household Car Owner

> *"Whenever I go to university, I would call a colleague of mine and tell her in advance that I'm going, say, tomorrow and ask whether she would like to join. She doesn't pay me for it, by the way, but I feel good doing it."* – B10, Female, 34, Licensed Driver, Primary Household Car Owner

> *"I think there is an element of carbon footprint and stuff. We all have got responsibility to reduce it. So, I do try and share. If I am going somewhere I know someone else is going to as well, I would offer a lift. And I do walk a lot as well."* – B07, Female, 29, Licensed Driver, Primary Household Car Owner

Therefore, concerns around diverse sustainability implications of car use were likely to have a positive influence on the uptake of MaaS as users saw it as a tool that would help them travel in a more sustainable manner:

"Going back to the sustainability thing, using MaaS would make me feel like I was contributing more to maintaining sustainability." – H03, Female, 51, Licensed Driver, Primary Household Car Owner

Theme Two: Trust

Trust in this analysis developed as a theme explaining how perceptions of MaaS' functionality influence its acceptance and viability as a travel mechanism. While on a theoretical level MaaS generated a great deal of enthusiasm among study participants, many of them did not trust that the concept could actually work as advertised:

"It's the release of a new service, and then how much trust would you have in it to deliver? If it had any sort of issues, then you'd be left to your old ways of doing things." – L13, Male, 29, Licensed Driver, Non-Car-Owning

"If I could just get to work in the morning by, say, Uber, after work take a bus to the train station, get down to London by train and then travel around there, and it all would be for that one fixed monthly price, it would be great, but I find it hard to believe. I don't believe it's possible." – B01, Female, 27, Licensed Driver, Member of Car-Owning Household

The theme is discussed in greater detail in the following sections covering five main expressions, or sub-themes, of Trust. The developed sub-themes are related to the need of ***trialling*** MaaS, the ***efficiency*** of the tool, the transportation ***capacity*** on offer, concerns related to ***technology*** use when travelling with MaaS, ***cyber-security*** threats associated with transport digitalisation, and the societal ***digital readiness*** for MaaS-like travel systems.

Trialling

To make sure that MaaS is fully functional and delivers on its promise some study participants demonstrated the need for trialling the tool prior relying on it for their everyday travel needs:

"I can actually use this service to test the accuracy in the city I live, with travel routes that I'm confident of, and if I see it is very accurate, then I could travel from Birmingham to, say, Leeds, and I'd want to use MaaS." – B04, Male, 29, Licensed Driver, Non-Car-Owning

"I'd say it would depend on my experience the first time I used it. If it all went efficiently, that would be great, and I'd use it again. If I had to wait around, if it was no better, then I'd rather do the journey myself." – H04, Female, 53, Licensed Driver, Primary Household Car Owner

"This should be tested as a pilot first to see how the technology works. And even with the quality of networks we have in here, I would still like to see how seamless, how efficient it is, even just in the city centre." – B08, Male, 36, Licensed Driver, Primary Household car Owner

Efficiency

Many interviewees doubted the efficiency of MaaS. Some participants, certain of their transport knowledge and planning capabilities, demonstrated a strong sense of self-efficacy and, thus, did not believe that MaaS could do better than them in planning and routing:

"You could obviously ticket all this yourself and, in fact, if you were in London, you could just get a day ticket and use any form of transport." – H06, Male, 29, Licensed Driver, Primary Household Car Owner

"I can probably work out all my alternative routes quicker in my head than this application can." – L04, Male, 35, Licensed Driver, Primary Household Car Owner

"The only thing I find with using apps is when you've got an idea of a system, and you go on the app, and you go "how am I getting from A to B?" and the app tells you to go there, and you go there. And I think, well, actually, if I go that way it's better because it's cheaper, but because it's a minute longer than the other way, the app will tend to give you the quickest time, and it's not necessarily as flexible and giving you as many options." – L12, Male, 48, Licensed Driver, Primary Household Car Owner

The above partially occurred due to study participants doubting the information coming through MaaS platform would always be timely, accurate and trustworthy:

"I think with the on-route issues often the information that comes through is poor, and that's exactly the reason why, if something happens, no one quite knows what's gone wrong and why. And then you almost end up making that decision yourself." – L09, Male, 31, Licensed Driver, Primary Household Car Owner

"The issue can also be that to work effectively this platform should include information from various sources, like weather, traffic, delays and so on. How can we trust that information?" – H08, Male, 41, Licensed Driver, Primary Household Car Owner

"It also depends on where the traffic information comes from. If it is a trusted source, then you can count on MaaS and rely on that information, but if the information is taken from different websites that may not be legit, it all can just be a lie, and the traffic might not be as bad as they say." – H10, Male, 25, Licensed Driver, Primary Household Car owner

Capacity

Participants expressed capacity concerns suggesting that MaaS, if popular among transport users, may suffer from an overload of passengers on offered transport means and, thus, provide limited alternatives, or reduced capacity in them:

"If we imagine that everyone uses MaaS, we then need more public transport in terms of numbers; we need more taxis, buses, because everyone would use it. I'm thinking about peak times. If you want to book a taxi around school time in the morning, you won't be able to do it because it's so busy. If many people abandoned their cars, such things could become more frequent." – H08, Male, 41, Licensed Driver, Primary Household Car Owner

"Say, you've got this system in place now, and you want to go from A to B. You may actually not have a chance of sharing a bike or sharing a car because there are so many people using MaaS there isn't just one available for you." – B02, Male, 64, Licensed Driver, Primary Household Car Owner

"On the bus or on the train, you'd have to worry if you'd get a seat or not, if it's a long journey." – H11, Female, 25, Licensed Driver, Primary Household Car Owner

Technology

It was acknowledged by participants that trusting the technology could become yet another challenge when travelling with MaaS. Participants thought of MaaS as an app-based tool, which induced concerns about simple practicalities like internet coverage in different places across the country:

“The only thing is Wi-Fi, the internet connection.” – H02, Female, 36, Non-Driving, Member of Car-Owning Household

"What happens if you lose signal? How do you recover from that? If you are in the underground, there is a proportion of time when you are not going to be able to get signal. So, how is this system then going to keep on top of everything?" – L14, Male, 28, Licensed Driver, Primary Household Car Owner

"The only thing would be signal. It would be frustrating because there are still many places where the signal just wouldn't be good enough." – B07, Female, 29, Licensed Driver, Primary Household Car Owner

Another technological concern, discussed by study participants, which could have a significant impact on their travel experiences with MaaS, was the life of mobile phone battery:

“If your phone is not charged, you can’t get access to MaaS, and then you’re lost. You can’t just rely on it.” – H05, Male, 24, Licensed Driver, Primary Household car Owner

"And I’ve just noticed that your smart device is your ticket, and I have a tendency of letting my phone run out of battery." – L01, Male, 28, Licensed Driver, Non-Car-Owning

"With such platform you need to constantly have your mobile device around you. If you have low battery and don't have a charger available or a place to charge your phone, that becomes a problem." – B03, Male, 32, Licensed Driver, Non-Car-Owning

The above issues, in some cases, meant the participants preferred unimodal shared use mobility services to public transport based multimodal travel as a means of risk mitigation:

“I don’t like the idea of the ticket being on my phone. Once you’re in an Uber, even if the phone dies, you can still travel point to point with that single mode, whereas if I was going somewhere and I was changing the transport modes, I’d have no ticket. It would be tricky for them to identify me. So my phone being the ticket could be a drawback unless there was a backup for it and the way I could still use everything. Not sure though how I would still get the directions. I’d just get lost not knowing where I got to go and not having my ticket with me.” – B05, Male, 27, Licensed Driver, Primary Household Car Owner

Cyber-security

Another issue undermining study participants' trust in MaaS was associated with concerns about possible cyber-security threats that could affect MaaS systems. Some worried about the possibility of MaaS system being hacked:

> *"It could endanger lives one way or another if the hackers, terrorists break into MaaS system."* – H07, Male, 56, Licensed Driver, Primary Household Car Owner

Sharing personal data with digital systems for some interviewees was an experience they were already familiar with; hence they were opened to sharing their data also with the MaaS system without having any concerns in the back of their head:

> *"It's just how much information you input into that. You do that for just buying clothes online, or through the app. So, people are already used to sharing their information everywhere."* – B06, Female, 24, Licensed Driver, Primary Household car Owner

> *"I don't mind sharing information, I'm not a secret agent or anything like that. We share information every single day via any other app. Even just to use your phone you have to give up your location to a certain extent without even knowing that."* – H09, Male, 28, Licensed Driver, Primary Household Car Owner

> *"If people are fine providing all the information to Uber, and it is a less consolidated experience, I don't see why people wouldn't do the same with MaaS to get something better."* – B04, Male, 29, Licensed Driver, Non-Car-Owning

Others, however, appeared reluctant to sharing their personal data with MaaS in return for a seamless mobility service and needed reassurance regarding what was happening to the data they share:

> *"I don't like my phone to have access even to my e-mails. I would rather have other ways of doing this, having something alternative."* – B09, Male, 39, Licensed Driver, Non-Car-Owning

> *"My only other question would be if MaaS worked out all your en-route issues, if your phone is tracking you, and I assume that if it is following your progress it is tracking you, how and what is it doing with that tracking data? As sad as I am, I don't like*

companies tracking me, having my data, and me not knowing what happens with that data." – L14, Male, 28, Licensed Driver, Primary Household Car Owner

The study participants were particularly cautious with regards to sharing their credit card details with the MaaS as they feared being charged incorrectly for their trips:

"It's asking for payment through the app, and I would want some kind of reassurance that this is fine." – L06, Female, 36, Non-Driver, Member of Car-Owning Household

"If something goes wrong with it, if payments are charged when they shouldn't be or if there is overpayment or anything like that, people might not want to rely on it." – L07, Female, 28, Licensed Driver, Member of Car-Owning Household

"Every mobile app that requires credit card details and payment is always a concern. If it is not widely used, then how safe is it? I suppose all this ApplePay is quite safe, but you don't put your details into every other app. It will need some time for me to trust it." – H14, Male, 36, Licensed Driver, Primary Household Car Owner

Digital Readiness

The trust in MaaS and its capabilities were also largely influenced by the individual state of digital readiness, or the level of knowledge of and experience with mobile devices and digital applications. So, some study participants stated how they or their significant others were not comfortable with using smart devices:

"I don't think my brother has ever even used Uber. He calls taxis because he is not very good with phones." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

"I never use apps and things. I'm not into technology. I don't trust a lot of this sort of stuff, I just do it the old way. It's just an age thing I guess. I don't know if it's ever going to work properly or not, so I don't bother with it." – B02, Male, 64, Licensed Driver, Primary Household Car Owner

"There are still people, like my parents, who just wouldn't use apps because they are scared of technology. If that continues to be an issue, with older generations especially, that would be something that would stop those people from using MaaS." – L07, Female, 28, Licensed Driver, Member of Car-Owning Household

Study participants also stated that journeys requiring several transport modes may already be difficult to perform for some people, with smart devices and apps complicating multimodal travel even further:

> *"I suppose people who are a little bit older would probably struggle with the concept of using mobile phone and an app to access different transport modes, especially since it brings together things like ride-sharing and ride-hailing. Slightly older generations wouldn't be comfortable using such services and would probably just use a bus or a car as a stand-alone."* – H12, Male, 19, Licensed Driver, Primary Household Car Owner

Theme Three: Human Element Externalities

The participants worried that MaaS would be operating in a framework defined by negative aspects of human behaviour, which could hinder their willingness to travel with MaaS. These issues come under the umbrella term Human Element Externalities. This is a theme that highlights some of the grey areas for the transition to a MaaS-based transport paradigm that relate to social environment barriers:

> *"The problem is not with the transport itself. The problem is with people."* – B01, Female, 27, Licensed Driver, Member of Car-Owning Household

Human Element Externalities can be traced in the user and provider levels, and in the following sections will be explained through the sub-themes related to transport provider and driver ***negligence***, anti-social behaviour of fellow travellers, or in other words ***discourtesy and abuse***, and the consequent ***danger anticipation*** when using shared means of transport.

Negligence

Participants of this study worried about receiving honest, safe and reliable service from transport providers due to having already experienced the negligence of those who cater for them, which is not guaranteed to be battled through MaaS:

> *"Will those offering driving services be malicious and want to go via routes that take longer and cost you more purposely to get more money?"* – L13, Male, 28, Licensed Driver, Non-Car-Owning

"The reason I would still use a car over this would be independence. With MaaS you're still reliant on people, you're still reliant on someone for a taxi, a bus, a train, and anything can happen." – B07, Female, 29, Licensed Driver, Primary Household Car Owner

"Drivers don't really care. They, most of the time, just fly about, and not safely, to get you there as quickly as possible. I think they can cancel on you quite easily, there is no repercussions. You're completely in their hands. I've been in some pretty scary journeys in different parts of the world, where I wasn't sure if I was going to live or die because drivers were mental." – L04, Male, 35, Licensed Driver, primary Household Car owner

Discourtesy and Abuse

Participants also discussed the negative impact discourtesy of other transport users has on their transport related experiences. First and foremost, participants were concerned with the numbers of people trying to get on public transport means at rush hour and appeared averse to travelling in crowded environments:

"For example, if you take a train at rush hour you can't get a seat, you can barely breath. That's how packed it is. People just squash against you, and that really puts me off sometimes." – H11, Female, 25, Licensed Driver, Primary Household Car Owner

"If you go on a train from Huddersfield towards Leeds, it's always packed at rush hour time. I don't like that. I just don't like the environment of people. If it was an empty bus or an empty train, I'd be much better, but I don't like the crumped closed-in environment." – H03, Female, 51, Licensed Driver, Primary Household Car Owner

The above partially occurred due to study participants having experienced fellow travellers being inconsiderate of their personal space, privacy and the need for peace and quiet:

"Then there are other people on the bus: some are considerate and think about the fact that they are not alone, and then others can listen to loud music or talk as if they were on their own on that bus, and everyone has to listen to their plans or whatever they did." – H01, Female, 26, Non-Driver, Member of Car-Owning Household

"Public transport suffers from the manner of people, especially in Birmingham where there are a lot of negative social vices going on." – B03, Male, 32, Licensed Driver, Non-Car-Owning

"If the train was nice and quiet, it would be great. But you know, if it's really busy, you can't get a seat, and that's a pain, and then obviously if it's full of noisy people you can't concentrate on reading." – H04, Female, 53, Licensed Driver, Primary Household Car Owner

People abusing the rules and the infrastructure put in place for everyone's good, could also become an issue even in the MaaS era:

"For me buses are just not well looked after, you've got a lot of abusive people on there, you've got some people smoking in the back though smoking is clearly not allowed. There are also regular attacks on the bus against women." – B07, Female, 29, Licensed Driver, Primary Household Car Owner

"Public transport is usually full of young people coming from parties, and they like to swear and smash stuff." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

"I think that cyclists running red lights and not sticking to cycle lanes, using the pavements and things like that isn't good for anybody." – H06, Male, 29, Licensed Driver, Primary Household, Car Owner

Danger Anticipation

Consequently, many anticipated that travelling by non-private transport could impose danger to their health and wellbeing, and even life, which made them reluctant to sharing transport means with others:

"At the train station, you get all these drugged, drunk people late at night, and if you're arriving late and waiting for your taxi there, then you're susceptible to harm. Not that you would definitely get harmed, but it puts that fear in your head, that it's really dark, the train station staff are not there, and you might have your possessions with you, like laptops, so you might feel more susceptible to harm." – H11, Female, 25, Licensed Driver, Primary Household Car Owner

"Travelling with members of public and having witnessed on occasions fights on trains, especially out of normal work hours, there's a sense of security that concerns me sometimes. If it's late at night and I'm travelling alone, I kind of think whether I want to take that risk." – L06, Female, 36, Non-Driver, Member of Car-Owning Household

"I'm not very good with the sole security element, with not knowing who I'm with. I don't know how I feel about sharing." – L10, Female, 35, Licensed Driver, Primary Household Car Owner

"The area of my work is not nice, and you wouldn't want to be on a bus there, unfortunately, unless you've got a stab-proof vest on." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

Interestingly, while generally being concerned about sharing the means of transport, study participants appeared to have a clear preference for one mode over another in terms of safety and risk mitigation, associated with other transport users. Some respondents preferred to use publicly shared cars:

"When using a taxi or Uber you're not in your own vehicle, but you are not sharing with others either. Late at night public transport could be quite a special experience." - L09, Male, 31, Licensed Driver, Primary Household Car Owner

"And then at night it's just safer to take a taxi or Uber, although I'm not sure: recently we've been hearing a lot about some "driver" situations." - L07, Female, 28, Licensed Driver, Member of Car-Owning Household

More often, however, a preference for public transport, as a safer than shared car option, was shown:

"I'd rather get public transport than get a taxi. I feel safer on public transport." – L05, Female, 39, Licensed Driver, Primary Household Car Owner

"UberPool is used in London quite a lot, but I was there alone, and it was quite late at night, and I didn't want to risk it. So I just sat in the bus, went to my hostel." – H11, Female, 25, Licensed Driver, Primary Household Car Owner

"When you use public transport in general, you have to travel with the general public, that's tolerable, but actually having to share a car, it doesn't appeal to me at all." – L12, Male, 48, Licensed Driver, Primary Household Car Owner

Theme Four: Added Value

This theme discusses what users would Value when shifting to a MaaS-dictated travel paradigm; the things that make a difference and the benefits those could bring to the logistics of their trips, positively influencing the shift to MaaS based travel:

> *"We as people have our own bias, the perception. With MaaS you can see something different than what you are used to."* – L11, Male, 35, Licensed Driver, Primary Household Car Owner

The valuable aspects of MaaS are presented in the sections below as sub-themes talking about ***appification and integration*** of transport services, the solid grounds MaaS provides for ***breaking habits***, the ***analytics*** behind MaaS system, provision of ***accounts and feedback*** feature for transport providers, drivers and fellow travellers, the benefits for ***ad-hoc travel***, and the potential of MaaS to push for improvements in the ***level of service provision***.

Appification and Integration

Whilst being challenging for a few, the appification of travel planning with MaaS was what excited most participants and was even referred to as a major selling point as it was something they were already accustomed to:

> *"MaaS being an app is one of its major selling points I would have thought."* – L08, Male, 53, Licensed Driver, Primary Household Car Owner

> *"It's easy enough. Anyone these days has a phone that can support it. I already have a few apps on my phone."* – H02, Female, 36, Non-Driver, Member of Car-Owning Household

> *"This app seems like a collection of several apps together, and it would be brilliant."* – B10, Female, 34, Licensed Driver, Primary Household Car Owner

The integration of a variety of transport options with information, booking and payment services in MaaS was perceived as another value-adding opportunity:

> *"It makes things much more convenient because you are able to get everything in one particular point. You are able to get information, you are able to get payments, and*

you are able to get tickets for the different services that you might be using." – B03, Male, 32, Licensed Driver, Non-Car-Owning

"I'm actually quite stupid when it comes to dealing with all the apps and searching for all the ways to get around is very difficult for me. If there is something that will tell me every step of the way, it would be very helpful." – B01, Female, 27, Licensed Driver, Member of Car-Owning Household

"I think if you can do one simple booking, one payment, all done through the app, I think that's very good." – L02, Male, 50, Licensed Driver, Primary Household Car Owner

Integration, interestingly, was also seen by some study participants as a way to partially overcome the digital readiness barrier by making travel easier and more accessible even to those who are older and not technologically enthused:

"Trying to find out the local bus operator, you might need to find their app, or use Google, so that takes time. If there was an app that gave you the opportunity to easily search for any location, without having to resort to different operators and stuff, that would be of interest to use. Someone who's older or not so strong with IT might struggle with MaaS. But then they would also struggle to find a local bus operator in a different town." – L12, Male, 48, Licensed Driver, Primary Household Car Owner

Breaking Habits

The integration feature has tempted participants to consider a change in their travel routine, thus showing potential to break habits of relying on cars and, ultimately, reduce car-caused congestion:

"MaaS might encourage people, if it's aimed that way, to walk or cycle more, if it could take them through routes which are more walking- and cycling- friendly." – H05, Male, 24, Licensed Driver, Primary Household Car Owner

"If you go shopping on a Saturday, instead of parking the car, if you book a taxi normally you would wait for it 10-15 minutes, do your shopping, book another taxi, wait another 10-15 minutes, whereas using this, you could walk a bit to the bus, get a bus, do the shopping, and then get a taxi because you have stuff to carry potentially. Or by the sounds of it, you could actually have it saying "well, you can get a bus now

instead of a taxi". So, I think it might make a more engaged experience, the fact that you can go "let's try that or that or that"." – L02, Male, 50, Licensed Driver, Primary Household Car Owner

"If I had MaaS and I could find a ride-share that goes to my work, I would never drive. I could completely stop driving and find an easy way to get there cheaper and simpler." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

The potential ability of MaaS to show transport users their carbon footprint or facilitate the use of more environmentally friendly transport modes was found by the study participants a particularly strong influence on the change of travel habits:

"It would be interesting to actually put something in MaaS that would tell you about the carbon footprint of each travel mode. I think that would be a bit of an eye-opener for some people and maybe influence their decision." – L05, Female, 39, Licensed Driver, Primary Household Car Owner

"If there was a proper service like MaaS, which could locate other users at the same area where I am and match the destinations, I would rather do that for all the environmental and social reasons." – B09, Male, 39, Licensed Driver, Non-Car-Owning

Analytics

Much thought was given to the analytics behind MaaS systems. Participants speculated that the data MaaS gathers from its users could be employed, one way or another, in improving travel experience. A few spoke about the ability of MaaS to manage capacity:

"I think, in terms of trains, they could do some research and actually let you know on what train you are likely to get a seat, or at what time it is going to be less busy. That would probably be quite beneficial because that could influence your decision positively if you knew the train that has actually got seats." – L05, Female, 39, Licensed Driver, Primary Household Car Owner

"It could be useful if this system had all this data about all the individual journeys taking place at the same time, so they could all be interrelated to each other depending on where everybody is going and where from. Say, there could be a hundred people trying to get from A to B. MaaS could then start making decisions so

that not everyone goes from A to B the same way as that would cause problems. So, by understanding what journeys people are trying to make, this system could eliminate bottlenecks potentially." – L14, Male, 28, Licensed Driver, Primary Household Car Owner

Accounts and Feedback

Participants also speculated that MaaS could, to some extent, eliminate the risks associated with service and other users by allowing to create accounts and give feedback to drivers and fellow travellers:

"It's the safety the application provides. All the accounts are connected to the user, so there is transparency. If something happens, you are able to identify and locate the person who was responsible for the issue occurred." – B09, Male, 39, Licensed Driver, Non-Car-Owning

"Another positive is that you can use feedback systems to rate your experience with every driver: it is an incentive for the drivers to be well-behaved because they know that the negative feedback will affect their own service." – B04, Male, 29, Licensed Driver, Non-Car-Owning

"I think they should cover everything, not just the car, but also the people you share that car with. You may feel a bit safer that way." – H10, Male, 25, Licensed Driver, Primary Household Car Owner

Ultimately, by rationally processing user data, MaaS could become a socially inclusive transport tool and create a more enjoyable travel experience:

"MaaS might make transportation become more social, which at the moment is not. So, you end up on trains where everyone is very passive aggressive, or just aggressive, people don't really talk to each other. You might end up with more people who travel together and enjoy their journey a little bit more." – L04, Male, 35, Licensed Driver, Primary Household Car Owner

Another dimension of this sub-theme, discussed by study participants, related to feedback given to MaaS system by other MaaS users, with the ability to influence transport users' opinions and drive towards using MaaS:

"While I would consider what I hear about the advantages from the people I know, that would not ultimately make the decision for me. But, of course, that would elicit a consideration." – B03, Male, 32, Licensed Driver, Non-Car-Owning

"If I heard good stories, and that MaaS was successful, and people were happy using it, I would try it, but then decide if I am a user or not based on my own experience." – H11, Female, 25, Licensed Driver, Primary Household Car Owner

"I would probably use MaaS from time to time if it was available in my area. But that still would depend on how good other people's experience with it is, and that would influence my decision to use it." – H13, Male, 24, Licensed Driver, Primary Household Car Owner

Ad-Hoc Travel

When talking about using MaaS for travel, participants often referred to trips with specific purpose. For some, occasional long-distance trips appeared most feasible to be planned and executed using MaaS rather than the private car:

"In terms of longer one-offs, specific journeys, I would think twice whether I want to drive all the way or travel by a combination of modes with public transport. It's probably not going to be a massive change, but I do think there will be certain individual journeys where MaaS could be of use." – L08, Male, 53, Licensed Driver, Primary Household Car Owner

"I might say to myself, you know, to take a bus or a train, and the journey takes one hour 20 minutes, and I am at the beach in the summer. MaaS might actually make me think that it's not a bad option versus driving and potentially sitting in terrible traffic taking two and a half hours and costing a fortune." – L04, Male, 35, Licensed Driver, Primary Household Car Owner

For the most part, however, MaaS was seen as a suitable option for journeys where participants already used modes of transport other than the private car. Some thought they could benefit from using MaaS for their non-car-based commute, leaving the private car for leisure and family trips:

"But if I were to start going to work, for example, then MaaS would probably help me with that. I know it would be a pain taking the bus to town centre and then the train

and then whatever other means of transport I'd need to take. MaaS would make it easier for me and probably even shorten my route." – H01, Female, 26, Non-Driver, Member of Car-Owning Household

"It could work quite well for my commute because it would be the same route that I already take. But for weekends, when you've got your family and stuff, you want to do something different. Then, I guess, it might be quite hard to arrange something using MaaS rather than the car for the four of you to go somewhere." – L03, Male, 48, Licensed Driver, Primary Household Car Owner

"MaaS would be good to use for work, but for pleasure and being able to make that decision to go right here right now MaaS isn't a solution." – H09, Male, 28, Licensed Driver, Primary Household Car Owner

Others, on the contrary, assumed MaaS wouldn't be suitable for their commute as, going on the same journey almost every day, they already worked out the itinerary most suitable for their comfort needs and financial constraints. For leisure trips, however, the use of MaaS was a possibility:

"For a commute you would always kind of know your journey. You don't need this system for something that you do day in – day out. MaaS would be for one-off journeys for leisure, or that sort of thing." – L09, Male, 31, Licensed Driver, Primary Household Car Owner

"Work wise, I generally know what I need to do and how I'm going to do it. MaaS might make it more convenient to book it, but perhaps it'd be more suitable for leisure travel and unusual journeys." – L12, Male, 48, Licensed Driver, Primary Household Car Owner

Participants also noted how MaaS could extend beyond the country of their residence and help them plan the trips to and within foreign countries with the purpose of tourism, and even offer things to do along the way, which they would find beneficial:

"I'd be more inclined to use MaaS if I went on holiday, like if I could book a flight together with rail or bus ticket to my hotel, and that was all integrated and weighed out, then I would definitely be up for using it." – H13, Male, 24, Licensed Driver, Primary Household Car Owner

"On the continent I would definitely use MaaS. It would be very useful in some countries where the public transport and the signage are terrible." – L14, Male, 28, Licensed Driver, Primary Household Car Owner

"If it had points of interest or something like that, the things you could do when you get off that transport. It's like when you go into a foreign city, it could offer you bus tours and include that. Rather than just having transport offering across the city, you can go here and then see something." – H05, Male, 25, Licensed Driver, Primary Household Car Owner

Level of Service Provision

All of the above, however would mean nothing, as stated by participants, if the level of service provision, for public transport in particular, remains as it is at present:

"I get where other people come from, like they live in the middle of the town and they could get the bus quite easily, but I come from quite a rural area, so I am dependant on that car." - H13, Male, 24, Licensed Driver, Primary Household Car Owner

"If I'd like to get in the centre of Birmingham, I will usually go on a train, not drive, whereas if I was going to the Isle of Skye in Scotland, I'd drive instead, if you know what I mean." – B07, Female, 29, Licensed Driver, Primary Household Car Owner

"At times I would so much rather use the car if I had one, but this thought is highly connected to the quality of public transport service." – B09, Male, 39, Licensed Driver, Non-Car-Owning

Thus, the true value of MaaS is in providing users with a robust transportation network that encourages public transport and meets their everyday travel needs:

"On a Sunday there is a bus only every 30 minutes, so of course I usually use my car. If MaaS offered me the flexibility of the public transport and a better frequency, then I might use that instead. If on a Sunday it is still difficult to do that, then MaaS makes no sense. I would want that to be 24/7 the same. Public transport is not the same 24/7. That guarantee that I would have the opportunity to use public transport whenever I want, that would be something." – H14, Male, 36, Licensed Driver, Primary Household Car Owner

"Encourage public transport networks that work with each other, that serve what people actually want, that run late in the night, that run at weekends, a bus that departs 5 minutes after a train arrives. You can't do this anymore in this country. We have lost that ability of actually getting everything to interwork with each other but that would actually make a big difference in choices people make." – L09, Male, 31, Licensed Driver, Primary Household car Owner

Theme Five: Cost

The Cost of MaaS was projected to be perhaps the most critical factor for its uptake. Although there was a specific cost related question within the interview guide, cost as an influencing factor appeared in the responses long before the question was asked. So, the following were some of the responses to the question on whether the participants were willing to use MaaS at the start of the interview:

"My decision would probably depend on price." – H01, Female, 26, Non-Driver, Member of Car-Owning Household

"It depends on the cost." – L11, Male, 35, Licensed Driver, Primary Household Car Owner

"If MaaS was more expensive than what I am doing, I don't think I would even try it." – H14, Male, 36, Licensed Driver, Primary Household Car Owner

The ways participants expressed their views on what the cost of MaaS should be took many different directions. These views were grouped into three sub-themes of Cost, namely ***benchmarking against status QUO***, the opposing attitude ***Why to pay? Can do myself***, and the financial ***incentives, reliefs and motives*** that could be used as influences on participants' decision to use MaaS instead of their car.

Benchmarking Against Status QUO

One of the ways to express the acceptable cost of MaaS was to do benchmarking against status quo. Some participants, to consider travelling with MaaS, wanted to see the cost of their travel reduced:

"I would use it if it worked out cheaper than going individually, like if I took a taxi to Huddersfield centre, it would be one price, but if it was a taxi and a bus ride it would be cheaper. Then I'd be more inclined to use it." – H13, Male, 24, Licensed Driver, primary Household Car Owner

"I am topping up my Oyster card £30 a week and that's to cover all my transport. So, I would want to see that reduced." – L01, Male, 28, Licensed Driver, Non-Car-Owning

Though it was noted that fixed costs of car ownership and use were often neglected when choosing to drive, car users noted that travelling with MaaS should work out cheaper than using their own car:

"If MaaS didn't make my trip more cost-effective, then I would question why I am using it really. So, I would expect it to be less expensive than using my own car. But then, if you were to weigh up all the fixed costs of having your own car, then I think it will be cheaper because you don't have to pay for all the outlay of the car, the insurance, and everything that goes with it." – H03, Female, 51, Licensed Driver, Primary Household Car Owner

"It would need to be quite a bit cheaper than what I need to pay to run my car. I think, having your own car is quite convenient, but obviously there is a cost to it. I understand MaaS integrates various ways of sharing, and obviously it will impact the cost. But still, it would need to work out cheaper doing it as MaaS suggest than doing it with your own car." – L03, Male, 48, Licensed Driver, Primary Household Car Owner

"It is like £25 for me to get home on a train. If it was the same with MaaS, I would probably just get in my car." – H12, Male, 19, Licensed Driver, Primary Household Car Owner

"While it costs me £5 a day in diesel to get to work and back, it costs me £6 on a train, so it's more. If with MaaS it was going to cost me £3 and take roughly the same amount of time, I would use MaaS." – B02, Male, 64, Licensed Driver, Primary Household Car Owner

Some participants appreciated the fact that MaaS was providing them not only with transportation, but also the bundling, payment and guidance services, for which they were ready to pay:

“I think I’d be willing to pay a little bit extra to get the full service.” – L10, Female, 34, Licensed Driver, Primary Household Car Owner

"I think people would pay that little bit more because it does more, and I'd be ready to pay a little bit more." – B06, Female, 24, Licensed Driver, Primary Household Car Owner

"I think generally people would be quite happy to pay a little bit more if it all fits in as well as it says it would." – L02, Male, 50, Licensed Driver, Primary Household Car Owner

"The price can be even a little bit higher than that of driving a car, but the experience has to be worth it." – B01, Female, 27, Licensed Driver, Member of Car-Owning Household

Many discussed the importance of time the travel with MaaS would take against the cost of the service and would like to see that factored in:

"Comparing the costs would certainly be interesting as well as comparing the journey times." – L08, Male, 53, Licensed Driver, Primary Household Car Owner

"Say, I'm going from A to B, and it normally takes me one hour. I can go with MaaS if it takes me one hour and 10 minutes. I wouldn't mind the 10 minutes as long as it works out cheaper." – L11, Male, 35, Licensed Driver, Primary Household Car Owner

"People don’t care about when they get to the station, all they want to know is what time they are going to get there. I think it would be useful to put MaaS against the car. I’d probably be like ah, actually, the public transport is only 10 minutes different. So, these end-to-end journey times would be useful. If it worked and wasn’t too expensive, I would probably use it instead." – L09, Male, 31, Licensed Driver, Primary Household Car Owner

Why to Pay? Can do myself

While some study participants were ready to pay for the digital services MaaS provided, others considered it unjust and developed a “Why to pay? Can do myself”’ attitude:

"If I see that in the end this works out, say, £10 more expensive than just using Google maps and doing it yourself, like dealing with Virgin trains, me and other people will

just go for a cheaper option, because the more travel is done by a more cost-effective option, the more you would end up saving." – B04, Male, 29, Licensed Driver, Non-Car-Owning

"If that was a journey that I could easily do myself and that journey was going to be a lot more expensive through MaaS, then I perhaps would be inclined to just do it myself." – H04, Female, 53, Licensed Driver, Primary Household car Owner

Incentives, Reliefs and Motives

A number of proposals to provide MaaS users with financial incentives, reliefs, and motives within the pricing structure in order to influence their travel behaviour occurred. Some study participants spoke about incentivising users through the app:

"If you were to pick one way, and you had a train, for example, would you get a discount for using the train through the app because you are choosing to do that over taking your own car? I think that would influence people." – L05, Female, 39, Licensed Driver, Primary Household car Owner

"You could give people bonuses, something like reward points every now and then: a free trip after 10 trips done with MaaS, or a free mile after every 100 miles travelled. Give people an incentive to use it. Bribe them. Freebies usually work." – B05, Male, 27, Licensed Driver, Primary Household Car Owner

"If you wanted this to take off in any sort of big numbers, then you have to be very careful of what you offer because a lot of people only want things that are free." – L08, Male, 53, Licensed Driver, Primary Household Car Owner

The government interference, with both "push" and "pull" pricing measures, was also considered a mechanism to influence participants' decision to use MaaS:

"The government should offer credits, where you get your money back, or you're not taxed as much because you don't have a personal car. If you pay £100 for your car emissions, then you're not paying it, but maybe you should get a flipside where they say "ok, because you use MaaS you get some return as an incentive." – L02, Male, 50, licensed Driver, Primary Household Car Owner

"If they would make travelling by my own car, like through taxes, , unbearably expensive, then I would be forced to use public transport, but I wouldn't like to see that. But it can be an option for the government, increasing the cost of owning a car, and that could push people to use MaaS." – H09, Male, 28, Licensed Driver, Primary Household car Owner

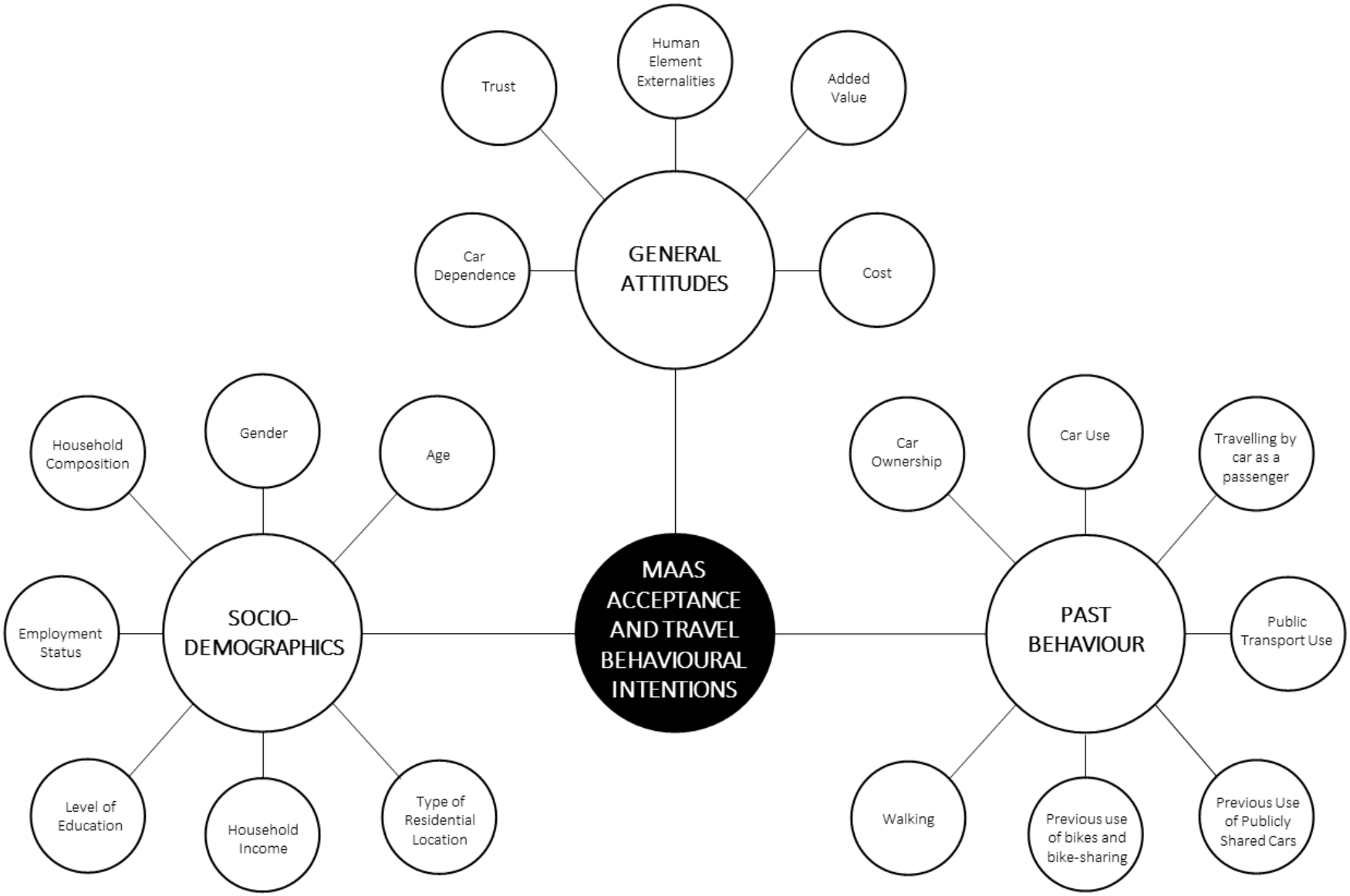
4.6. Conclusions: Enhancing the Framework

The qualitative research phase enhanced the author's understanding of MaaS in the context of travel behaviour and emphasised the factors that influence acceptance and travel behavioural intentions with MaaS by examining transport related experiences and attitudes of transport users reflecting and affecting the key phenomena under investigation. Data driven thematic analysis synthesised the views of the UK based transport users on challenges they could potentially experience when adopting a MaaS based transport paradigm and opportunities for MaaS based travel. The five themes that emerged from the thematic analysis are:

- Car Dependence;
- Trust;
- Human Element Externalities;
- Added Value; and
- Cost.

These are the key attitudinal factors influencing transport users' travel behavioural intentions with MaaS that need careful policy attention to support its sustainable uptake. As mentioned in Section 4.2, the set of attitudinal factors affecting MaaS acceptance and use, identified via literature review, was used solely for the development of the interview guide; the analysis of the collected via interviews data, as explained in Section 4.4, was not theory-driven (i.e., the findings of the literature review were no longer used). Thereby, a new set of attitudes defining the uptake of MaaS was developed: the identified five themes are now referred to as MaaS Attitudes and replace General Attitudes in the developed via literature review framework. An updated framework, which will be used for further investigation, is presented on Figure 4.6.1.

Figure 4.6.1: Qualitatively Enhanced Conceptual Framework



CHAPTER 5. QUANTITATIVE PHASE AND ANALYSIS

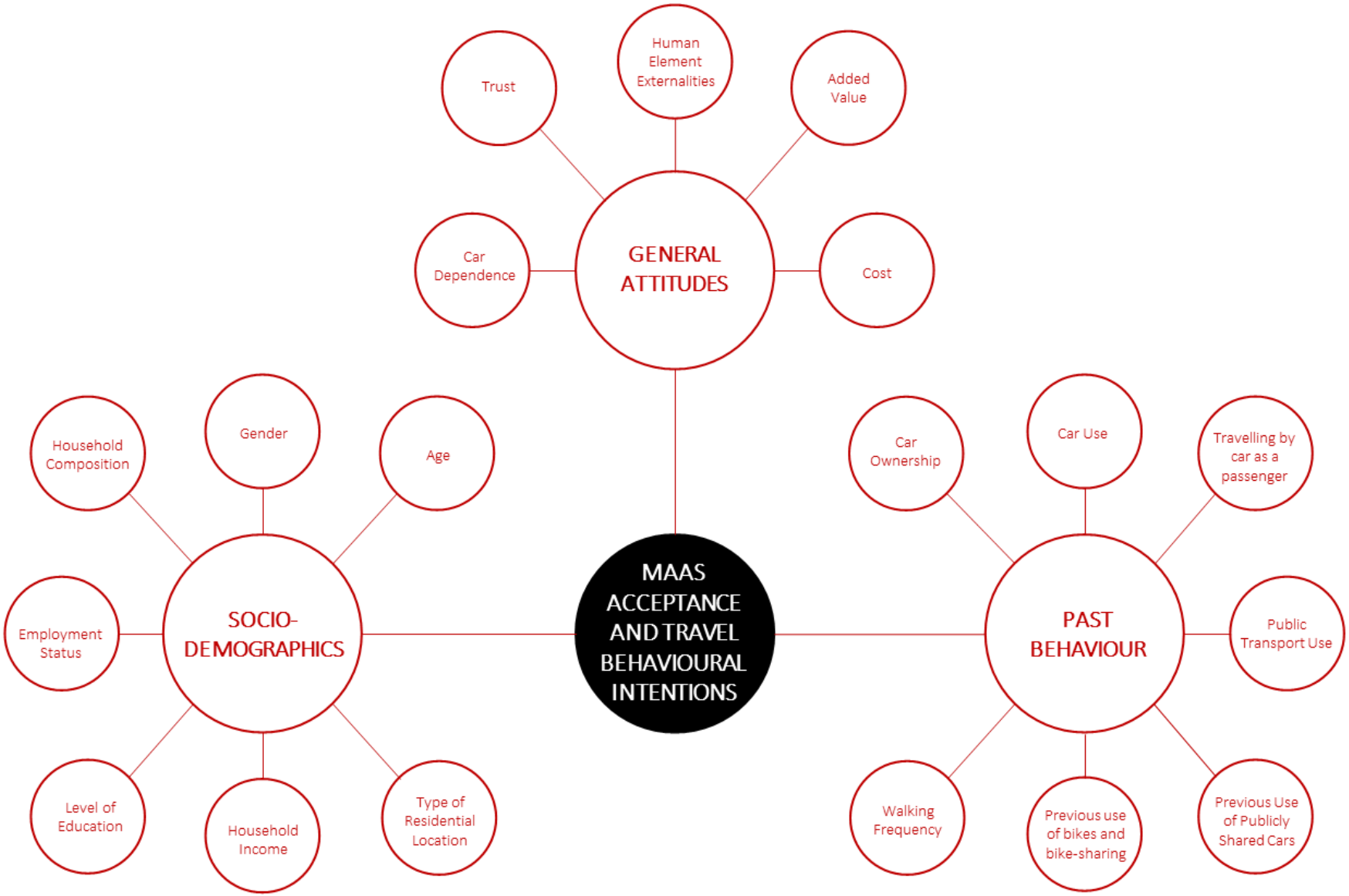
5.1. Introduction

This chapter presents the key stages of the quantitative phase of this research. First, the development of a survey instrument is described, followed by the report of recruitment and the surveying process. The sample and its characteristics are also presented. The description of step-by-step statistical analysis and the overview of quantitative findings gathered using each of the procedures complete the chapter.

5.2. Survey Instrument Development

Online self-administered quantitative survey instrument was written based on the conceptual framework, developed via literature review, and enhanced qualitatively, as presented on Figure 5.2.1, with the lines of quantitative inquiry highlighted in red. Therefore, the survey instrument was aimed at studying the attitudinal drivers of MaaS, namely car dependence, trust, human element externalities, added value, and cost, but also the past behaviour and socio-demographic characteristics of individuals, and how those affect MaaS acceptance and travel behavioural intentions. The survey was developed using Qualtrics and consisted of six parts: screening questions; residential location information; past behaviour questions; attitudinal Likert-scale statements; intentional Likert-scale statements; and socio-demographics. The "forced response" function was adopted within the survey to ensure respondents did not miss any of the questions. The detailed process of survey instrument development is presented in the following chapter sub-sections. While the process of developing survey section is described further in this chapter, the survey itself can be found in Appendix I.

Figure 5.2.1: Applying Conceptual Framework - Quantitative Inquiry



5.2.1. Attitudinal Likert-Scale Statements

The main idea behind development of the survey instrument was to ensure it reflects the Thematic Map produced qualitatively, and, as the qualitative phase focused on understanding the attitudinal drivers of intentional travel behaviour with MaaS, its findings were used to produce a set of attitudinal Likert-scale statements. There were five core themes identified through qualitative inquiry that are believed to be the driving factors of MaaS travel behavioural intentions. These themes, namely Car Dependence, Trust, Human Element Externalities, Added Value, and Cost, all had sub-themes, as presented on Thematic Map, and the related data extracts. As the objective of this quantitative inquiry is to test this set of developed qualitatively attitudinal factors alongside socio-demographic and past behaviour variables, these attitudinal factors had to be translated into a quantitative survey language. Thus, the statements for the survey were developed by taking sample extracts from each sub-theme and rephrasing those in way that was more context free and comprehensible to survey respondents. A total of 40 Likert-scale statements were developed, each pertaining to different sub-themes and derived from a specific data extract and supplied with five categorical answers from *strongly disagree* to *strongly agree*. Table 5.2.1, or the *Joint Display* created to ensure *mixed methods rigour*, presents each of the developed attitudinal statements, the matching data extracts, and the sub-themes and themes these extracts fall under.

Table 5.2.1: Joint Display - Likert-Scale statements developed using Thematic Map and related Data Extracts

THEME	SUB-THEME	EXAMPLE DATA EXTRACT		SURVEY STATEMENT	
CAR DEPENDENCE	Convenience	L06	*"If you take the bus or the train, you can get longer waiting times or delays that you're not in control of, compared to when you're driving your car."*	IV_01	I travel by car to have more predictable journey times
CAR DEPENDENCE	Convenience	H06	*"If it was as a daily commute, I'm not sure you could make MaaS cheap enough to convince me. I'd rather just get in my car."*	IV_02	I travel by car because it is cost-effective
CAR DEPENDENCE	Convenience	B11	*"If I had any luggage, it's just a matter of moving it from home straight into the car, and it's all part of convenience."*	IV_03	I travel by car because I can carry luggage/shopping/all the things I need without hassle
CAR DEPENDENCE	Convenience	H02	*"Sometimes you do need to drive, if it's raining, for example."*	IV_04	I travel by car to avoid harsh weather
CAR DEPENDENCE	Convenience	B12	*"Compared to public transport and other modes, car is a lot safer"*	IV_05	I travel by car because I feel safe this way
CAR DEPENDENCE	Enjoyment	B02	*"The car is all my own environment, so I can turn on my Radio1 and relax more. You know, I've got my personal little bit of space."*	IV_06	I travel by car to have the privacy I don't get on other means of transport
CAR DEPENDENCE	Convenience	H09	*"You know, with my car I'm not restricted to the timetables of trains, for example, and places where I can go. I get more choice."*	IV_07	I travel by car to be independent of public transport
CAR DEPENDENCE	Convenience	B08	*"I think the convenience and the comfort for my family is more important here. For that, I would not want to swap my personal car for MaaS."*	IV_08	It's necessary to own a car if you have a family
CAR DEPENDENCE	Enjoyment	B04	*"People feel secure when they have their own stuff, and having a car is having your own thing. You would prefer that and the benefits it brings any time of the day."*	IV_09	Owning a car is good because it's having your own thing
CAR DEPENDENCE	Convenience	L10	*"It probably sounds really stupid, but I like knowing that the car is there if it's an emergency."*	IV_10	Having your own car is necessary for cases of emergency/ disruption

Table 5.2.1 (Continued): Joint Display - Likert-Scale statements developed using Thematic Map and related Data Extracts

THEME	SUB-THEME	EXAMPLE DATA EXTRACT		SURVEY STATEMENT	
CAR DEPENDENCE	Enjoyment	H13	*"In my family everybody has got a car, so it would be quite weird if I didn't have one."*	IV_11	I would own a car because people, important to me, also own cars
CAR DEPENDENCE	Enjoyment	H07	*"I enjoy driving because of the comfort of driving and because I love driving. I'm so happy when I drive, I'm so comfortable."*	IV_12	I travel by car because I enjoy driving/being in a car
CAR DEPENDENCE	Morality	L10	*"Whilst I am very aware that there is a problem, it's not a big enough problem for me to say that I'm not going to use my car anymore."*	IV_13	The environment does not concern me
CAR DEPENDENCE	Morality	B05	*"If I cause emissions or something, that wouldn't make any difference to me. My car wouldn't make that much difference if I stopped driving."*	IV_14	I think me using a car has little to do with climate change
CAR DEPENDENCE	Morality	B11	*"If everyone uses a car that is environmentally safe in terms of emissions, like I do, then we would have a safer environment. So, on my part I know that I use something environmentally friendly."*	IV_15	I think congestion is not an issue for the environment
TRUST	Digital Readiness	B05	*"I don't think my brother has ever even used Uber. He calls taxis because he is not very good with phones."*	IV_16	I would struggle to use a mobile device and an app to access different transport modes
ADDED VALUE	Appification & Integration	H02	*"It's easy enough. Anyone these days has a phone that can support it. I already have a few apps on my phone."*		
TRUST	Technology	H05	*"If your phone is not charged, you cannot get access to MaaS, and then you're lost. You can't just rely on it."*	IV_17	I would worry whether my mobile device has got enough battery
TRUST	Technology	B07	*"The only thing would be signal. It would be frustrating because there are still many places where the signal just wouldn't be good enough."*	IV_18	I would worry about the quality of internet coverage where I am going
TRUST	Cyber- Security	L06	*"It's asking for payment through the app, and I would want some kind of reassurance that this is fine."*	IV_19	I would worry whether I am being charged correctly for my trips
TRUST	Cyber- Security	L14	*"As sad as I am, I don't like companies tracking me, having my data, and me not knowing what happens with that data."*	IV_20	I would not want to share my personal data with MaaS

Table 5.2.1 (Continued): Joint Display - Likert-Scale statements developed using Thematic Map and related Data Extracts

THEME	SUB-THEME	EXAMPLE DATA EXTRACT		SURVEY STATEMENT	
TRUST	Cyber- Security	H07	*"It could endanger lives one way or another if the hackers, terrorists break into MaaS system."*	IV_21	Cyber-security behind MaaS system would concern me
TRUST	Efficiency	H08	*"The issue can also be that to work effectively this platform should include information from various sources, like weather, traffic, delays and so on. How can we trust that information?"*	IV_22	I would not trust the travel information coming through the MaaS app
TRUST	Capacity	B02	*"You may actually not have a chance of sharing a bike or sharing a car because there are so many people using MaaS there isn't just one available for you."*	IV_23	I would worry whether there would be a publicly shared car or bike available for me at the time I need it
TRUST	Digital Readiness	H12	*"Slightly older generations wouldn't be comfortable using such services and would probably just use a bus or a car as a stand-alone."*	IV_24	I would struggle to travel by a combination of transport modes
HUMAN ELEMENT EXTERNALITIES	Danger Anticipation	L10	*"I'm not very good with the sole security element, with not knowing who I'm with. I don't know how I feel about sharing."*	IV_25	I wouldn't like to share the means of transport with people I don't know
HUMAN ELEMENT EXTERNALITIES	Discourtesy & Abuse	B03	*"Public transport suffers from the manner of people, especially in Birmingham where there are a lot of negative social vices going on."*	IV_26	I would stress about the inconsiderate behaviour of fellow travellers
HUMAN ELEMENT EXTERNALITIES	Discourtesy & Abuse	H11	*"For example, if you take a train at rush hour you can't get a seat, you can barely breath. That's how packed it is. People just squash against you, and that really puts me off sometimes."*	IV_27	I wouldn't like to be in a crowded environment
HUMAN ELEMENT EXTERNALITIES	Negligence	B07	*"With MaaS you're still reliant on people, you're still reliant on someone for a taxi, a bus, a train, and anything can happen."*	IV_28	Having to rely on other people for my transport would concern me
ADDED VALUE	Breaking Habits	L05	*"It would be interesting to put something in MaaS that would tell you about the carbon footprint. I think that would be a bit of an eye-opener for people and maybe influence their decision."*	IV_29	I would use MaaS if I were informed about my contribution to reducing carbon footprint
ADDED VALUE	Breaking Habits	H05	*"MaaS might encourage people, if it's aimed that way, to walk or cycle more, if it could take them through routes which are more walking- and cycling- friendly."*	IV_30	I would use MaaS if I knew I was contributing to the reduction of overall congestion levels

Table 5.2.1 (Continued): Joint Display - Likert-Scale statements developed using Thematic Map and related Data Extracts

THEME	SUB-THEME	EXAMPLE DATA EXTRACT		SURVEY STATEMENT	
ADDED VALUE	Level of Service Provision	H14	*“Public transport is not the same 24/7. That guarantee that I would have the opportunity to use public transport whenever I want, that would be something."*	IV_31	I would use MaaS if it offered me a more frequent and flexible public transport service day and night
ADDED VALUE	Analytics	L05	*“I think, in terms of trains, they could do some research and actually let you know on what train you are likely to get a seat, or at what time it is going to be less busy."*	IV_32	I would use MaaS if I were informed about the availability of seats on different transport modes
ADDED VALUE	Accounts & Feedback	H10	*"I think they should cover everything, not just the car, but also the people you share that car with. You may feel a bit safer that way."*	IV_33	If I could see, through MaaS platform, rating and feedback for drivers and fellow travellers, I would use MaaS
ADDED VALUE	Accounts & Feedback	B03	*"While I would consider what I hear about the advantages from the people I know, that would not ultimately make the decision for me. But, of course, that would elicit a consideration."*	IV_34	My decision to use MaaS would depend on the people who already used it
COST	Benchmarking against Status Quo	L01	*“I am topping up my Oyster card £30 a week and that’s to cover all my transport. So, I would want to see that reduced.”*	IV_35	I would use MaaS if travelling with it worked out cheaper than what I currently spend on my transport
COST	Benchmarking against Status Quo	B06	*"I think people would pay that little bit more because it does more, and I'd be ready to pay a little bit more."*	IV_36	I would pay more for MaaS than what I currently spend on my transport
COST	Benchmarking against Status Quo	H12	*"It is like £25 for me to get home on a train. If it was the same with MaaS, I would probably just get in my car.”*	IV_37	I would use MaaS if travelling with it would cost me about the same as what I currently spend on my transport
COST	Incentives Reliefs & Motives	H09	*"But it can be an option the government could look at, increasing the cost of owning a car, and that could push people to use MaaS."*	IV_38	If government increased the cost of car ownership and private car use, I would use MaaS
COST	Incentives Reliefs & Motives	L02	*"The government should offer credits, where you get your money back, or you're not taxed as much because you don't have a personal car."*	IV_39	If government offered financial reliefs for switching from private car to MaaS, I would use MaaS
COST	Incentives Reliefs & Motives	B05	*“You could give people bonuses, something like reward points every now and then. Give people an incentive to use it. Bribe them. Freebies usually work."*	IV_40	I would use MaaS if I were offered bonus points and discounts for trips through MaaS app

5.2.2. Intentional Likert-scale Statements

Intentional Likert-scale statements were designed using both the literature and the qualitative findings. A total of nine intentional Likert-scale statements were developed for the survey, each asking the respondents to provide the level of likelihood they assign to them with regards to their future behaviour. The options to select from, as mentioned previously, were provided in a form of a five-point scale from *extremely unlikely* to *extremely likely*. The nine items included two acceptance intentions and seven travel behavioural intentions, both sustainable and unsustainable. The two acceptance intentions included the items *"I would use MaaS on a pay-as-you-go basis"* and *"With MaaS I would choose the daily/weekly/monthly package payment option".* Two travel behavioural items focused on general behavioural implications of MaaS and included the intentions *"With MaaS I would consider not owning a car"* and *"With MaaS I would replace some of my public transport trips with publicly shared cars"*. Another two travel behavioural items concerned MaaS trip generation implications and included the intentions *"I would travel to places I couldn't get to before if MaaS offered me transport options to do it"* and *"Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment".* The remaining three items were aimed at measuring mode switching intentions with MaaS in a more specific context; thus, these intentions focused on commuting and included the item *"I would use MaaS and commute by public transport combined with other transport options",* the item *"I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use",* and the item *"I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know".* Importantly, commuting was explained to full time and part time employed respondents as travel to and from place of work to students as travel to and from educational establishment, and to unemployed and retired as travel to their most frequent destination, and thus applied as a trip purpose to respondents with either employment status.

5.2.3. Socio-Demographic Features

As individual demographics, according to the Literature Review Chapter, have potential to explain travel behaviours and travel behavioural intentions, the survey instrument developed asked its respondents to provide their demographic characteristics. These demographic features were tested during statistical analysis process, but also used to test how representative of studied general population is the sample obtained during this quantitative inquiry. So, the demographics

section of the survey included similar to the defined through Literature Review categories of *Gender*, with options of *Male*, *Female*, or *Other* to choose from; *Age* with options of *18-24*, *25-34*, *35-44*, *45-54*, or *55+*; *Marital status* with options of *Single*, *Married/ Domestic Partnership*, *Divorced*, or *Widowed*; *Family status* with options of *Without children*, *With children under 18*, or *With children over 18*; *Status of employment* with options including *Employed full time*, *Employed part time*, *Unemployed looking for work*, *Unemployed not looking for work*, *Retired*, and *Student*; *Level of education* with either *Secondary School, High School*, *College*, *Bachelor's degree*, *Master's degree*, or *Doctorate* to select from; and lastly *Rough annual income of household after tax* which could either be *£0 to £15.000*, *£15.000 to £30.000*, *£30.000 to £50.000*, *£50.000 to £75.000*, or *£75.000+*. With regards to the type of residential location, the participants were asked to provide their precise residential area in the UK by typing its name down in the text box, but also were asked what type of residential area they came from, with the set of choices including *rural area*, *town centre*, *town suburb*, *city centre*, and *city suburb*. Participants were also provided with an option *prefer not to say* in case some questions, in their opinion, requested sensitive information. It is also important to note that the demographics section appeared at the end of the survey. Such strategy was adopted to potentially include the survey responses where the respondents "quit" completing the survey at the demographics section, as their answers could still be used for testing other variables, and with their demographic characteristics recoded into *prefer not to say*.

5.2.4. Past Behaviour Items

In line with the conceptual assumptions highlighted in the Literature Review Chapter, to allow for building an understanding of sample's *past behaviour* related to travel and learning about their currently preferred transport options, prior providing the level of agreement with each of the generated MaaS related Likert-scale attitudinal statements and intentional statements, survey participants were asked to specify the frequency of using different transport options available for use in the UK. In order to shorten the survey, the many transport options available in some cases were grouped. So, car-based options such as taxi, ride-hailing and carsharing, accessed for individual use, were grouped into the category *Publicly shared car for my own use* with the examples of Taxi, Uber, and Zipcar specified in brackets to ensure the notion of the category was clear to the respondents. Similarly, options such as ride-sharing, carpooling and organised sharing of taxi were grouped into the category *Public car shared with others* with the examples of Taxi share, UberPool, and BlaBlaCar specified in brackets. Transport options, such as bus, tram, and train, were grouped into the category *Public Transport*. Using personal bike or a public bike-sharing

scheme both came under the category *Cycling or Bike-sharing.* Driving a private car and being a passenger in a private car came under two separate categories of *Private car as a driver* and *Private car as a passenger* accordingly. The list of travel options was completed with the category of *Walking*. The frequencies for the use of each transport mode to select from included *Daily*; *Few times a week*; *Once a week*; *At least once a month*; *Rarely*; and *Never*. In addition, the participants were asked to provide the mode of transport they regularly use for their commute. Commute implied travel to work establishment for those employed full time or part time; travel to a place of education for those unemployed but currently studying; and travel to the most frequent destination for unemployed and retired transport users. The options for selection included *active* travel for those commuting by either walking, cycling, or bike-sharing; *private car as a passenger*; *private car as a driver; private car with public transport*; *public transport* for those using it as a stand-alone or combining it with active modes of travel; *public transport with public car*; and *public car* as a stand-alone.

5.3. Recruitment and Surveying Process

Similar to the interviewing process, the surveying process started with the search for participants. Although non-probability sampling approaches were used, the aim was still to achieve a sample reasonably representative of general population of the UK; though, the inability of an online survey instrument to target individuals who did not have access to or were simply unable to use the means of digital communication, such as computers, tablets, and smartphones, remained a limitation to some extent. To achieve the desired sample the following strategies were used. First, for a *self-selection sampling* approach, a call for participants message was advertised on author's LinkedIn and Facebook profiles explaining the criteria for participation: participant's age being 18 and over and residency in the UK; though, participants were also "scanned" within the survey. Author's LinkedIn and Facebook connections based in the UK include both students from Bachelor's to Doctorate level and full-time and part-time employed people up to 65 as well as some retired individuals. Then, the call for participants was also advertised by the author in Facebook communities, such as city/town-based communities and survey exchange communities. To increase the number of participants, another self-selection strategy was employed: a call for participants leaflet with a barcode, scanning which using smartphone would direct the participants to the survey, was designed, printed, and dropped off to mailboxes in residential areas of Leeds and Huddersfield as well as put up in some public places around the above-mentioned locations. To boost the number of responses even more, the author relied on *convenience sampling* and sent

direct messages to Facebook and LinkedIn connections who had not participated in the research as well as her e-mail contacts; these messages were also used to request those personal contacts to share the link to the survey via e-mail or social media with their workplace or university colleagues. Finally, to partially overcome the targeting limitation, some of the author's personal ties who were unable to complete the survey using the digital communication means were offered a paperback survey to fill in.

The surveying process took place between February and July 2020. As previously mentioned, the survey was designed using Qualtrics software. Prior full-scale implementation, the survey was piloted to ten students at the University of Huddersfield. The piloting helped make the wording of the questions more comprehendible and also determine whether the length of the survey was convenient for the respondents. After minor adjustments, the survey was distributed using the generated by Qualtrics software link and barcode. When following the link or scanning the barcode, survey participants were first directed to the participant brief explaining the nature of the study and the right to withdraw, but also including a consent form asking for permission to record, store, and use the survey output for academic and research purposes; participants gave their consent by clicking the "proceed" button. Although there was no set limit for the survey response time, each response took between seven and 30 minutes from start to completion, and a total of 427 transport users based in the UK aged 18 and over provided useable responses, 426 of which were fully completed, and one where the responses to demographics sections were missing, and consequently recoded into *prefer not to say*.

5.4. Quantitative Sample Characteristics

As mentioned in the above section, a total of 427 useable responses were gathered during the surveying process. The survey responses came from various places around the UK, and the sample was, at least in part, representative of country's adult general public. An outlook at the sample's socio-demographic details and travel behaviour are provided further in this section.

5.4.1. Respondents' Socio-Demographic Profile

As evident from Table 5.4.1, gender split of the sample was close to that of the UK population in general. According to 2011 Census data (Office for National Statistics, 2011), there were 49.3% male and 50.7% female residents in the UK. A total of 194 survey responses, or 45.4%, came from male participants and 230 responses, or 53.9% were received from female participants.

The age split, however, did not reflect the general population numbers. So, the majority of survey responses, or 144, came from individuals aged 18 to 24, making 33.7% of the sample, whilst only 11.4% of population in the UK belong to that age group. Second biggest number of answers, or 138, came from individuals aged 25 to 34, making 32.3% of the sample, whilst only 17.2% of population in the UK belong to that age group. The 17.6% of answers coming from participants aged 35 to 44 somewhat matched the general population number of 16.3%. Only 9.4% of responses, as opposed to 17.9% in national statistics, came from individuals aged 45 to 54. Even less responses, or 6.8%, came from individuals whose age was above 55, which is different from the general population numbers by over 30%. Thus, the majority of sample were young, which was expected given the channels relied on for survey distribution.

The number of survey respondents in possession of full car driving licence was 325, accounting for 76.1%. Thus, the percentage of license holders in the sample was extremely close to the 75% provided by the National Travel Survey (Department for Transport, 2020). With regards to the marital status, as many as 230 survey respondents, or 53.9%, were single, which exceeded the national statistics by around 19%. The partnerships in the population, on the other hand, were underrepresented by over 11% with 39.8% stating they were either in domestic partnership or married. The divorced population was also underrepresented with only 2.3% of respondents being divorced as opposed to 7.8% in the population of the UK. No widowed individuals were targeted by the survey, while there were 6.6% of widowed population in the UK in 2011.

Other demographic characteristics could not be compared to the national statistics, mainly due to the categories used in the survey not matching the categories used in national statistics. So, a total of 291 survey respondents, or 68.1% did not have children. Only 85 respondents, that being 19.9% cared for children under 18, while the rest had children who were over 18. As many as 301 survey respondents, or 70.5%, had achieved higher education levels and were in possession of either Bachelor's or Master's degrees. Less than a quarter, or 12.6% of respondents had doctorate qualifications, while the rest did not have university degrees. Most of the sample, or 195 respondents and 45.7%, were employed full time. Students were the second largest group, represented by 146 34.2% of the sample. As many as 12.2% of the sample were employed part time, while another 5.6% were unemployed, and 2.3% were retired. The majority of survey respondents, or 27.4%, reported their annual household income being between £30,000 and £50,000, while over 25% earned above £50,000.

Table 5.4.1: Quantitative Sample Characteristics

DEMOGRAPHIC CHARACTERISTICS	FREQUENCY IN SAMPLE		
Gender	Male	194	45.4%
	Female	230	53.9%
	Other	3	0.7%
Age	18-24	144	33.7%
	25-34	138	32.3%
	35-44	75	17.6%
	45-54	40	9.4%
	55+	29	6.8%
	Prefer not to say	1	0.2%
Full car driving license	No	102	23.9%
	Yes	325	76.1%
Marital status	Single	230	53.9%
	Married/Domestic Partnership	170	39.8%
	Divorced	10	2.3%
	Widowed	0	0.0%
	Prefer not to say	17	4.0%
Family status	Without children	291	68.1%
	With children under 18	85	19.9%
	With children over 18	35	8.2%
	Prefer not to say	16	3.7%
Level of education	Secondary School	10	2.3%
	High School	9	2.1%
	College	52	12.2%
	Bachelor's degree	161	37.7%
	Master's degree	140	32.8%
	Doctorate	54	12.6%
	Prefer not to say	1	0.2%
Status of employment	Employed full time	195	45.7%
	Employed part time	52	12.2%
	Unemployed looking for work	17	4.0%
	Unemployed not looking for work	7	1.6%
	Retired	10	2.3%
	Student	146	34.2%
Rough annual income of household after tax	£0-£15,000	62	14.5%
	£15,000-£30,000	92	21.5%
	£30,000-£50,000	117	27.4%
	£50,000-£75,000	63	14.8%
	£75,000+	44	10.3%
	Prefer not to say	49	11.5%
TOTAL PARTICIPANTS		**427**	

5.4.2. Residential Locations

Red flags on Figure 5.4.1 present each of the 427 participants, in accordance with the place of residence named in the survey, on the map of the UK. Thus, the majority of responses came from South and Northern England as well as the Midlands. Although less, there were responses coming also from Wales and Scotland. No responses from Northern Ireland were obtained.

Figure 5.4.1: Quantitative Study Locations
Adapted from Google Maps

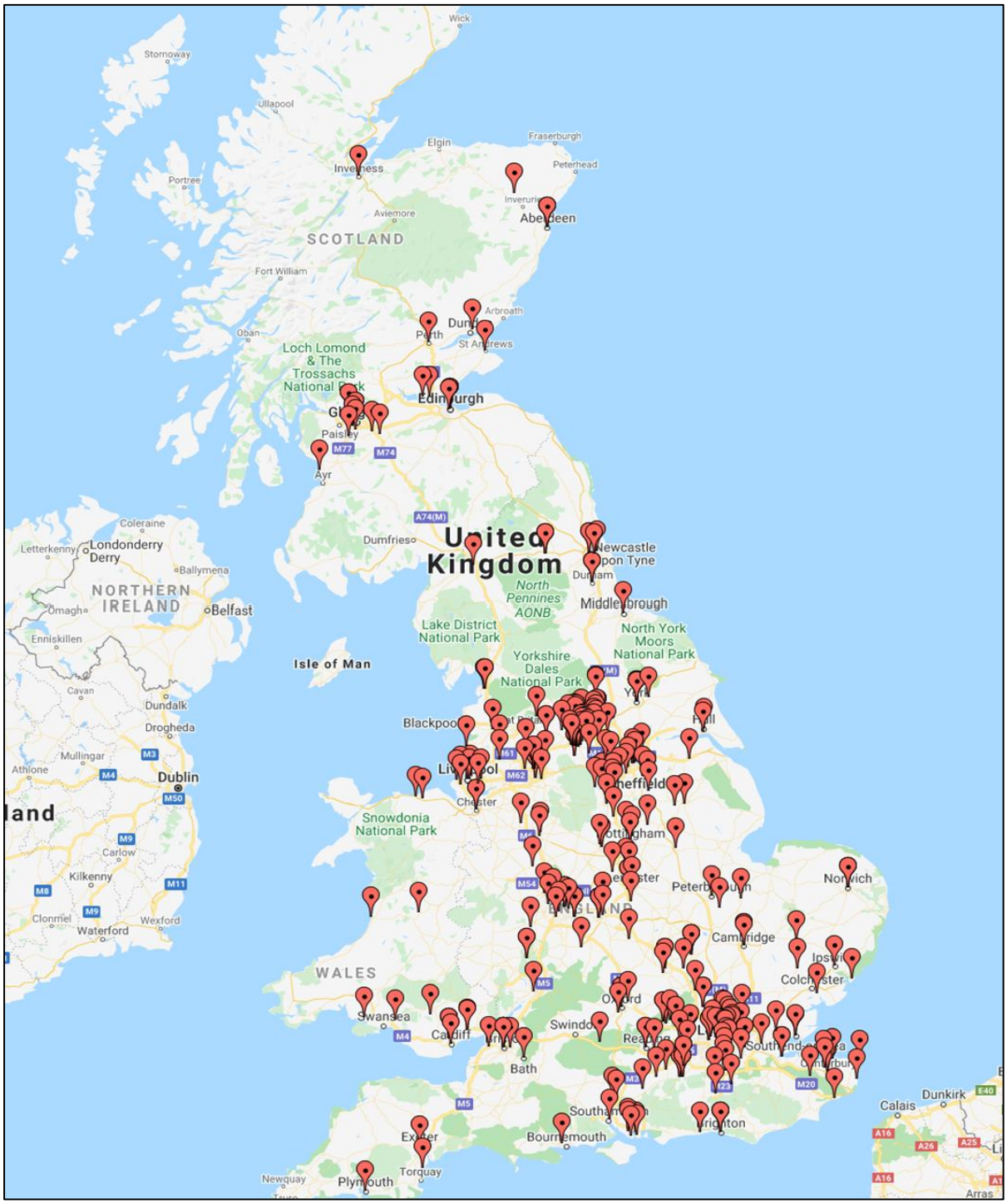


Table 5.4.2 lists top locations where the responses to the survey came from. The majority of survey respondents were based in London, with 55 out of 427, or 12.9%, identifying themselves as city based. Second largest group of respondents, with 36 out of 427, or 8.4% came from the town of Huddersfield. The town of Doncaster, and the cities of Leeds and Manchester completed the top five locations with most responses. A number of responses came from other major cities in the UK, e.g., Birmingham, Liverpool, Bristol, and Glasgow; the number of responses coming from each, however, was under double figures.

Table 5.4.2: Top Places of Residence

	FREQUENCY IN SAMPLE		
Place of residence	London	55	12.9%
	Huddersfield	36	8.4%
	Doncaster	22	5.2%
	Leeds	21	4.9%
	Manchester	14	3.3%
	Birmingham	12	2.8%
	Liverpool	9	2.1%
	Bristol	7	1.6%
	Glasgow	7	1.6%
	Other	244	57.1%
TOTAL PARTICIPANTS		**427**	

There were five types of residential locations participants could select from. So, according to Table 5.4.3 below, most of the survey respondents, or 213 out of 427 were residing in towns around the UK, with 54 respondents, or 12.6% residing in the centres, and 159 respondents, or 37.2%, residing in the suburbs of towns. Second largest group of survey respondents, or 143 out of 427, were city based, with 63 respondents, or 14.8% residing in the centres, and 80 respondents, or 18.7%, residing in the suburbs of cities. The smallest number of respondents, or 71 out of 427 and 16.6% of total sample, were based in rural areas around the country.

Table 5.4.3: Urban Form Characteristics

	FREQUENCY IN SAMPLE		
Urban Form	Rural area	71	16.6%
	Town centre	54	12.6%
	Town suburb	159	37.2%
	City centre	63	14.8%
	City suburb	80	18.7%
TOTAL PARTICIPANTS		**427**	

5.4.3. Respondents' Past Behaviour

There were seven transport options for which survey respondents had to provide their frequency of use: *Private car as a driver; Private car as a passenger; Public Transport (Bus/Tram/Train/etc.); Cycling or bike-sharing; Walking; Publicly shared car for my own use (Taxi/Uber/Zipcar/etc.); and Public car shared with others (Taxi share/UberPool/BlaBlaCar/etc.).* Also, participants had to provide information regarding car ownership in their household. As evident from Table 5.4.5, over 76% of survey respondents had at least one car in their household, which is slightly below the National Travel Survey (Department for Transport, 2020) statistics. According to participants' responses, walking was the most popular travel option, incorporated into daily trips by a total of 182, or 42.6%, of survey respondents. Second most popular transport option was, however, using private car as a driver, with a total of 135, or 31.6%, of survey respondents incorporating it into their daily trips. Another 18 survey respondents, or 4.2%, reported daily use of private car as a passenger. The third most popular travel option was, expectedly, public transport, with 60 survey respondents, or 14.1%, reporting its daily use. Only 14 survey respondents out of 427, or 3.3.% of sample, reported daily use of bikes; as many as 269 survey respondents, or 63% of sample, stated they never used bicycles. Publicly shared cars were also among the least popular travel options among survey respondents: only one survey respondent reported daily use of publicly shared cars on individual basis, and only three respondents reported daily use of collectively shared public cars. The respondents were also asked to provide the mode of transport they used for their regular commute. As per Table 5.4.4 below, 91 out of 427 respondents, or circa 21% stated they were active commuters. A total of 18 respondents, or circa 4%, travelled to their most frequent destination by private car as a passenger, while 186, or circa 44% were regular drivers. As many as 125 respondents, or circa 30% relied on public transport as a stand-alone or combined it with other transport for their commute. Only 7 respondents, or less than 2% travelled by publicly shared cars.

Table 5.4.4: Commute Transport Mode split across Sample

TRAVEL BEHAVIOUR	FREQUENCY IN SAMPLE		
Regular Commute Mode Choice	Private Car Driver	186	43.6%
	Public Transport	105	24.6%
	Active	91	21.3%
	Private Car Passenger	18	4.2%
	Private Car with Public Transport	12	2.8%
	Public Transport with Public Car	8	1.9%
	Public Car	7	1.6%
	TOTAL PARTICIPANTS	**427**	

Table 5.4.5: Sample Past Travel Behaviour

TRAVEL BEHAVIOUR	FREQUENCY IN SAMPLE		
Car Ownership	No	102	23.9%
	Yes	325	76.1%
Private car as a driver	Daily	135	31.6%
	Few times a week	79	18.5%
	Once a week	17	4.0%
	At least once a month	10	2.3%
	Rarely	49	11.5%
	Never	137	32.1%
Private car as a passenger	Daily	18	4.2%
	Few times a week	87	20.4%
	Once a week	51	11.9%
	At least once a month	79	18.5%
	Rarely	132	30.9%
	Never	60	14.1%
Public Transport (Bus/Tram/Train/etc.)	Daily	60	14.1%
	Few times a week	81	19.0%
	Once a week	45	10.5%
	At least once a month	75	17.6%
	Rarely	121	28.3%
	Never	45	10.5%
Cycling or bike-sharing	Daily	14	3.3%
	Few times a week	25	5.9%
	Once a week	17	4.0%
	At least once a month	18	4.2%
	Rarely	84	19.7%
	Never	269	63.0%
Walking	Daily	182	42.6%
	Few times a week	108	25.3%
	Once a week	32	7.5%
	At least once a month	34	8.0%
	Rarely	40	9.4%
	Never	31	7.3%
Publicly shared car for my own use (Taxi/Uber/Zipcar/etc.)	Daily	1	0.2%
	Few times a week	18	4.2%
	Once a week	25	5.9%
	At least once a month	89	20.8%
	Rarely	145	34.0%
	Never	149	34.9%
Public car shared with others (Taxi share/UberPool/BlaBlaCar/etc.)	Daily	3	0.7%
	Few times a week	7	1.6%
	Once a week	11	2.6%
	At least once a month	39	9.1%
	Rarely	100	23.4%
	Never	267	62.5%
TOTAL PARTICIPANTS		**427**	

5.5. Statistical Analysis Run-Up and Data Coding

For the purpose of the statistical analysis, all the data gathered from survey respondents were transformed into numerical format to fit the IBM SPSS Statistical software and grouped according to variables these data were pertaining to. The variables in SPSS can be labelled either as nominal, when their values represent categories with no intrinsic ranking; or ordinal, when their values represent categories with some intrinsic ranking, or scale. Initially, no scale type of variables was present in the data set. So, all the items focusing on participants' demographic characteristics and past behaviour were labelled as nominal, with each response category being given an index number; for example, when responding to a question regarding their gender, respondents could choose from the three options of *Male*, *Female*, and *Other*, which were coded as "1", "2" and "3" accordingly for the analysis purposes. The items representing attitudinal and intentional Likert-scale statements were labelled as ordinal, and each of the response options were coded as follows: *strongly disagree/extremely unlikely* as "1", *disagree/unlikely* as "2", *neither agree nor disagree/neither likely nor unlikely* as "3", *agree/likely* as "4", and *strongly agree/extremely likely* as "5". It can be noted that the attitudinal Likert-scale items, used in the survey and presented in the *Joint Display*, use both negative and positive wording. It is common practice to perform reverse coding in order to ensure all items in the survey, or variables, have the same direction. The author took the latter into consideration when running preliminary analysis. The results of the analysis, and EFA specifically, where the direction of the items may have impacted the results, were the same for items with and without reverse coding. For the aforementioned reason, the items used in the final analysis were not reverse coded.

5.6. Exploratory Factor Analysis

This section of the chapter presents the detailed analysis process and the results of EFA procedure. The approach to EFA adopted was *principal component analysis (PCA)* with *varimax rotation*. A total of eight factors that underpin MaaS travel behavioural intentions of transport users in the UK, were generated: Added Value; Car Use Convenience and Enjoyment; Human Element Externalities; Trust in Functionality; Cost; Car Use Morality; Trust in Enabling Technology; and Car Ownership Necessity.

5.6.1. Analysis Process

In line with the criteria set for ensuring *construct validity* in Section 3.5.4, prior to running a full-scale EFA, the author ran preliminary tests to determine whether further data collection was required. A total of 427 survey responses were collected for the 40 developed Likert-scale attitudinal statements, making the subject to indicator ratio surpass 10:1. According to Table 5.6.1, the *KMO Measure of Sampling Adequacy* resulted in the value of 0.853, which significantly exceeded the suggested bare minimum of 0.5. According to Hadi et al. (2015), KMO values between 0.5 and 0.7 suggest the sample is mediocre, values between 0.7 and 0.8 suggest the sample is good, values between 0.8 and 0.9 suggest the sample is great, and values above 0.9 suggest the sample is superb for factor analysis; therefore, the sample of 427 individuals, or subjects, was a great fit for EFA in the case of this quantitative inquiry. Moreover, *Bartlett's Test of Sphericity* had shown significant results, with p (Sig.) < 0.05, suggesting that the data provided by 427 subjects was adequate for EFA as the Likert-scale attitudinal indicators were proven to somehow correlate.

Table 5.6.1: Sample Minimum Standard Test

KMO AND BARTLETT'S TEST		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.853
Bartlett's Test of Sphericity	Approx. Chi-Square	6671.834
	df	780
	Sig.	0.000

The factorial structure in this quantitative inquiry is based on Rotated Component Matrix (Table 5.6.4), extracted using *principal component analysis (PCA)* with *varimax rotation.* The procedure converted 40 Likert-scale attitudinal variables into 10 latent variables, or factors. Table 5.6.2 shows how the variance is divided among the 10 extracted factors.

Table 5.6.2: Total Variance Explained by Factor Analysis Variables

TOTAL VARIANCE EXPLAINED			
Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
FACTOR 1	4.125	10.313	10.313
FACTOR 2	3.959	9.898	20.212
FACTOR 3	2.92	7.299	27.510
FACTOR 4	2.52	6.299	33.809
FACTOR 5	2.269	5.672	39.482
FACTOR 6	2.177	5.443	44.925
FACTOR 7	1.92	4.800	49.725
FACTOR 8	1.883	4.707	54.432
FACTOR 9	1.586	3.965	58.397
FACTOR 10	1.579	3.947	62.344

In line with Anable (2005), the developed through EFA constructs were tested for *internal reliability* using Cronbach α, and only the factors with internal reliability values of 0.7 and above were retained (O'Leary-Kelly & Vokurka, 1998). To calculate Cronbach α values for the generated factors, no items falling under each factor were deleted, although this procedure is often used to improve the values of Cronbach α (Gliem & Gliem, 2003). The values obtained are presented in Table 5.6.3. The results demonstrate that factors 1 to 8 all achieved internal reliability values above 0.7 – the benchmark for factor retention, and, therefore, were retained for further statistical analysis. Factors 9 and 10 failed the internal reliability test as their Cronbach α values were lower than the assigned benchmark of 0.7, with α of 0.354 and α of 0.575 accordingly. Thus, factors 9 and 10 were not used in further statistical analysis. As only 8 factors were retained, the total variance explained by the selected set of factors reduced to 54.432%.

Table 5.6.3: Cronbach's α of Factor Analysis Variables

FACTOR	VARIABLES LOADING	CRONBACH α
FACTOR 1	7	0.865
FACTOR 2	6	0.823
FACTOR 3	4	0.797
FACTOR 4	5	0.752
FACTOR 5	4	0.724
FACTOR 6	3	0.718
FACTOR 7	2	0.714
FACTOR 8	3	0.702
FACTOR 9	2	0.354
FACTOR 10	4	0.575

5.6.2. Overview of Findings

The generated by IBM SPSS Statistics Rotated Component Matrix Output, presented in Table 5.6.4, is the key for understanding the results of EFA. There, the 40 Likert-scale attitudinal variables are sorted in a "stair-step" manner. So, there were seven attitudinal variables loading on Factor 1. All the variables, with the exception of IV_40, according to Joint Display, belong to the theme Added Value and its underlying sub-themes. The IV_40, although initially coming under theme Cost, could be interpreted as a value-generating feature of MaaS rather than monetary incentive. Therefore, factor 1 was titled "Added Value". A total of six attitudinal variables loaded on factor 2, all belonging to the theme Car Dependence, and to its convenience and enjoyment sub-themes specifically. Therefore, factor 1 was titled "Car Use Convenience and Enjoyment". A total of four variables loaded on factor 3, all pertaining to the theme Human Element Externalities. Thus, factor 3 was titled accordingly. Another five variables loaded on factor 4, all of which belong to the theme Trust, and to its digital functions in particular. For this reason, factor 4 was titled "Trust in Functionality". Four variables loaded on factor 5, which belong to the theme Cost; they, however, are more focused on incentives associated with the cost of MaaS. Thus, factor 5 was titled "Cost Incentives". Three variables loaded on factor 6, all pertaining to morality dimension of theme Car Dependence; therefore, factor 6 was titled "Car Use Morality". Only two Likert-scale attitudinal statement loaded on factor 7 both pertaining to technology sub-theme of theme Trust. Cabrera-Nguyen (2010) suggest rejecting the factors with less than three variables loading on them. There were, however, only two statements assigned to technology sub-theme in the Joint Display. Therefore, factor 7 was retained and titled "Trust in Enabling Technology". Factor 8 had three variables loading on it, all belonging to the theme Car Dependence, but discussing the reasons for owning a car. Therefore, factor 8 was given a title "Car Ownership Necessity". Factors 9 and 10 had variables from a number of themes loading on them and, thus, were hard to define. These were not used in further analysis as they also failed internal reliability test.

Table 5.6.4: Results of Factors Analysis using PCA with Varimax Rotation

ROTATED COMPONENT MATRIX											
	ID	1	2	3	4	5	6	7	8	9	10
FACTOR 1: ADDED VALUE	IV_32	0.796									
	IV_33	0.791									
	IV_31	0.767									
	IV_30	0.698									
	IV_34	0.685									
	IV_29	0.628									
	IV_40	0.537									
FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT	IV_06		0.73								
	IV_12		0.718								
	IV_04		0.702								
	IV_05		0.701								
	IV_03		0.665								
	IV_07		0.662								
FACTOR 3: HUMAN ELEMENT EXTERNALITIES	IV_26			0.739							
	IV_25			0.734							
	IV_27			0.711							
	IV_28			0.692							
FACTOR 4: TRUST IN FUNCTIONALITY	IV_20				0.814						
	IV_21				0.782						
	IV_22				0.636						
	IV_19				0.541						
	IV_16				0.488						
FACTOR 5: COST INCENTIVES	IV_38					0.728					
	IV_39					0.727					
	IV_35					0.488					
	IV_37					0.45					
FACTOR 6: CAR USE MORALITY	IV_13						0.776				
	IV_15						0.766				
	IV_14						0.723				
FACTOR 7: TRUST IN ENABLING TECHNOLOGY	IV_17							0.833			
	IV_18							0.779			
FACTOR 8: CAR OWNERSHIP NECESSITY	IV_08								0.806		
	IV_10								0.712		
	IV_09								0.529		
FACTOR 9: MISC 1	IV_36									0.766	
	IV_11									0.451	
FACTOR 10: MISC 2	IV_02										0.646
	IV_01										0.508
	IV_23										0.484
	IV_24										0.48

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 8 iterations.

5.7. Univariate Analysis

This section of the chapter presents the detailed analysis process and the results of univariate analysis procedure. The analysis was performed for every Likert-scale attitudinal variable retained after EFA. For the presentation purposes, the variables are grouped in line with the results of EFA.

5.7.1. Analysis Process

To produce the output for univariate analysis, first, values for mean and standard deviation (SD), using IBM SPSS Statistics, were produced for every Likert-scale attitudinal statement that loaded on one of the retained factors. These values for 34 statements were then grouped according to the constructs produced via EFA. Then, a total of 34 frequency tables were produced, each showing the number of participants who either strongly disagreed, disagreed, neither agreed nor disagreed, agreed, or strongly agreed with the statement in question, and the related percentage. Then, the values of frequency tables were entered into MS Excel spreadsheet and grouped according to EFA output for producing the bar charts as they provide a better visual display of data than the frequency tables alone. The values of mean and SD were likewise entered into MS Excel spreadsheet, and the Likert-scale statements falling under each of the constructs were then sorted from the highest mean to the lowest.

5.7.2. Overview of Findings

This chapter subsection presents the output for univariate analysis. The discussion of results starts with the presentation of acceptance and intentional outcomes of the sample. As already mentioned, the statements used in the analysis, and their means, SD and frequencies were grouped according to EFA results. Thus, there are eight sections that follow, each presenting in table format and describing the output for means and SD as well as presenting the bar charts and providing description for the latter.

Acceptance Intentions

There were two MaaS acceptance intentions generated for this scientific inquiry, namely the intention *"I would use MaaS on a pay-as-you-go-basis"* and the intention *"With MaaS I would choose the daily/weekly/monthly package payment option".* All 427 survey participants provided their level of agreement with each of the intentional statements. The average responses for the

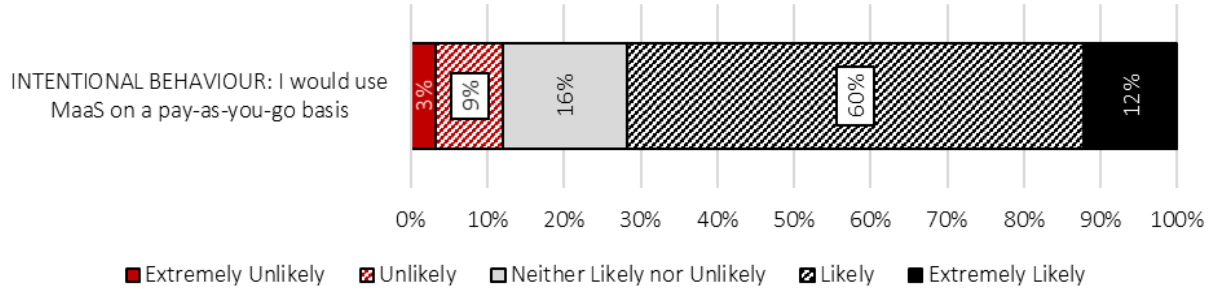
statement *"I would use MaaS on a pay-as-you-go-basis"*, as presented in Table 5.7.1, was marginally positive, as the mean for the statement equalled 3.69, thus falling above the value of 3 standing for "Neither Likely nor Unlikely" but below the value of 4 standing for "Likely".

Table 5.7.1: Mean and SD for Intention to use MaaS on pay-as-you-go basis

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
I would use MaaS on a pay-as-you-go-basis	427	1	5	3.69	0.911

According to Figure 5.7.1, as many as 72% of all survey respondents were either likely or extremely likely to choose pay-as-you-go option if MaaS was available on the market. Only circa 12% of respondents were either unlikely or extremely unlikely to do the latter, while the remaining 16% could not decide.

Figure 5.7.1: Frequencies for Intention to use MaaS on pay-as-you-go basis



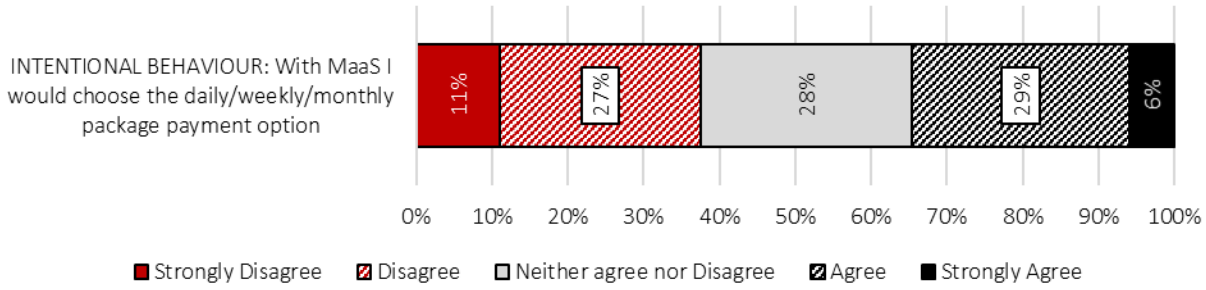
The average responses for the statement *"With MaaS I would choose the daily/weekly/monthly package payment option",* as presented in Table 5.7.2, was, on the other hand, generally negative, as the mean for the statement equalled 2.92, thus falling below the value of 3 standing for "Neither Likely nor Unlikely" but above the value of 2 standing for "Unlikely".

Table 5.7.2: Mean and SD for Intention to use MaaS in a bundle form

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
With MaaS I would choose the daily/weekly/monthly package payment option	427	1	5	2.92	1.106

According to Figure 5.7.2, only circa 35% of all survey respondents were either likely or extremely likely to choose a MaaS bundle be the service available to them. Around 38% of respondents were either unlikely or extremely unlikely to go for a MaaS bundle, and the remaining 28% could not decide.

Figure 5.7.2: Frequencies for Intention to use MaaS in a bundle form



Interestingly, only 25 out of 427 survey respondents, or circa 6% were either unlikely or extremely unlikely to use MaaS in both pay-as-you-go and bundle forms. As many as 43 respondents, or 10%, could not decide on either option. A total of 12 respondents, or 3% could not decide whether they would use a pay-as-you-go MaaS whilst being unlikely or extremely unlikely to use MaaS in a bundle form. Almost an equivalent number, or 2% of respondents were unlikely or extremely unlikely to use MaaS in a pay-as-you-go form while being indecisive about a MaaS Bundle. Almost a half of respondents, or 191 of 427 and 45%, were to some extent likely to use pay-as-you-go MaaS be it available to them while being unlikely to use MaaS in a bundle form. Only 32 out of 427 respondents, or 7%, were to some extent likely to use MaaS in a bundle form while refusing to use a pay-as-you-go MaaS. A total of 116 respondents, or 27%, were either likely or extremely likely to use MaaS in either pay-as-you-go or bundle forms.

General Travel Behavioural Intentions

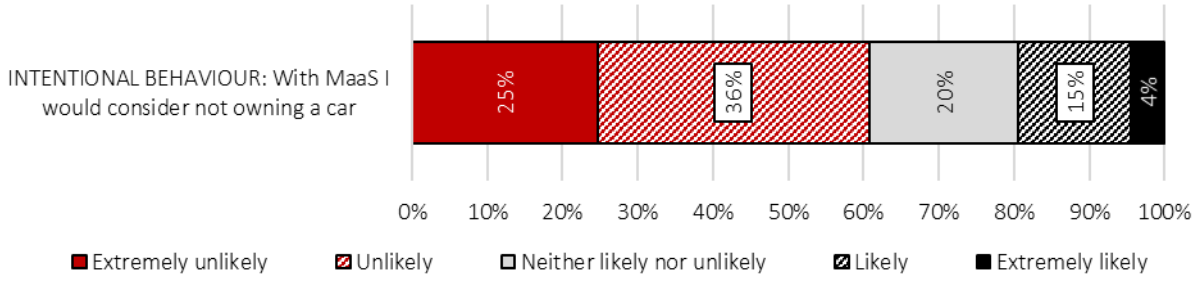
There were two general travel behavioural intentions generated for this scientific inquiry, namely the intention *"With MaaS I would consider not owning a car"* and the intention *"With MaaS I would replace some of my public transport trips with publicly shared cars".* All 427 survey participants provided their level of agreement with each of the intentional statements. As evident from Table 5.7.3, the mean for the statement *"With MaaS I would consider not owning a car"* achieved a value of 2.39, meaning survey respondents were on average unlikely to intend to behave according to the statement, as 2 for the intentional Likert-scale statements stands for "Unlikely" and 3 stands for "Neither Likely nor Unlikely".

Table 5.7.3: Mean and SD for Intention not to own a car

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
With MaaS I would consider not owning a car	427	1	5	2.39	1.14

According to Figure 5.7.3, as many as 61% of all survey respondents were unlikely or extremely unlikely not to own a car if MaaS was available to them. Only 19% of respondents were to some extent likely not to own a car, while the remaining 20% of respondents could not decide.

Figure 5.7.3: Frequencies for Intention not to own a car



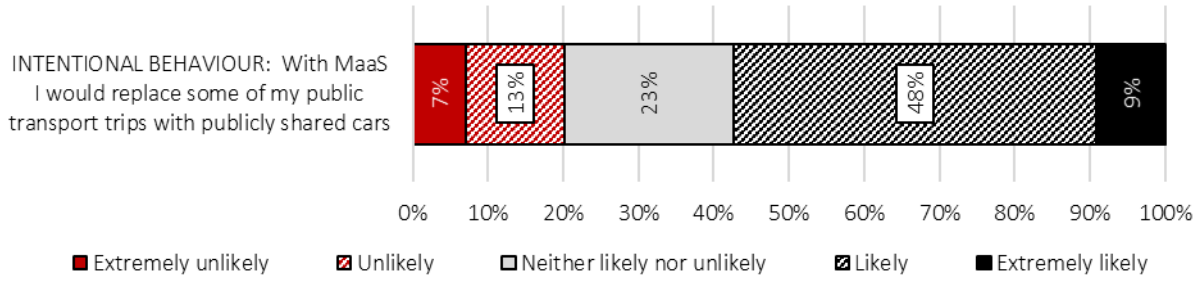
As evident from Table 5.7.4, the mean for the statement *"With MaaS I would replace some of my public transport trips with publicly shared cars"* achieved a value of 3.39, meaning survey respondents were on average likely to intend to behave according to the statement, as 3 for the intentional Likert-scale statements stands for "Neither Likely nor Unlikely "and 4 stands for "Likely".

Table 5.7.4: Mean and SD for Intention to replace public transport trips with publicly shared cars

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
With MaaS I would replace some of my public transport trips with publicly shared cars	427	1	5	3.39	1.052

According to Figure 5.7.4, as many as 57% of all survey respondents were likely or extremely likely to replace their public transport trips with publicly shared cars if MaaS was available to them. Only around 20% of respondents were to some extent unlikely to adopt the studied intention, while the remaining 23% of survey respondents could not decide.

Figure 5.7.4: Frequencies for Intention to replace public transport trips with publicly shared cars



Trip Generation Intentions

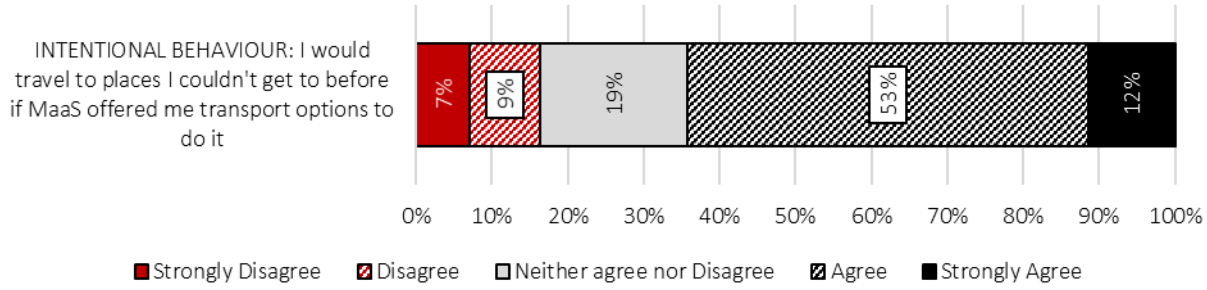
There were two trip generation intentional statements tested in this scientific inquiry, namely the intention *"I would travel to places I couldn't get to before if MaaS offered me transport options to do it"* and the intention *"Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment"*. Again, all 427 survey participants provided their level of agreement with each of the intentional statements. According to Table 5.7.5, the average responses for the statement *"I would travel to places I couldn't get to before if MaaS offered me transport options to do it"* achieved a mean value of 3.52, meaning the answers were generally positive, as 3 for the intentional Likert-scale statements stands for "Neither Likely nor Unlikely "and 4 stands for "Likely".

Table 5.7.5: Mean and SD for Intention to travel to new locations

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
I would travel to places I couldn't get to before if MaaS offered me transport options to do it	427	1	5	3.52	1.044

According to Figure 5.7.5, almost 65% of all survey respondents were likely or extremely likely to travel to places they could not travel to before if MaaS was available to them. Only around 16% of respondents were to some extent unlikely to behave according to the statement, while the remaining 19% of survey respondents could not decide.

Figure 5.7.5: Frequencies for Intention to travel to new locations



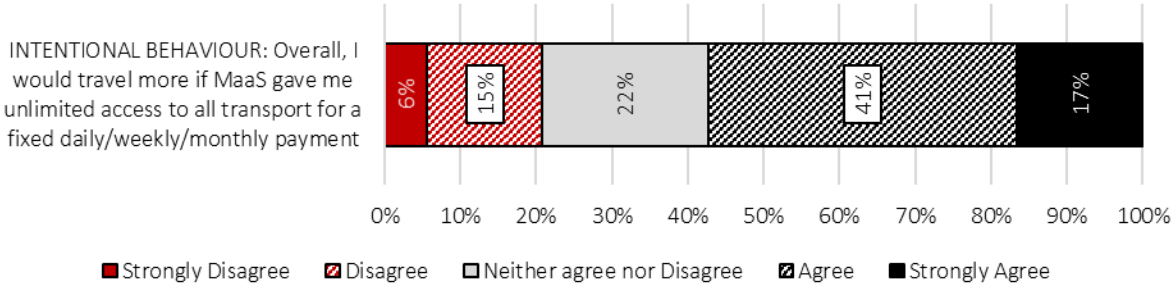
As presented in Table 5.7.6, the mean for the statement *"Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment"* achieved a value of 3.48, meaning survey respondents were on average likely to behave according to the statement, as 3 for the intentional Likert-scale statements stands for "Neither Likely nor Unlikely "and 4 stands for "Likely".

Table 5.7.6: Mean and SD for Intention to travel more overall

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment	427	1	5	3.48	1.107

As presented on Figure 5.7.6, around 58% of all survey respondents were likely or extremely likely to travel more if MaaS was available to them and gave access to all transport for a fixed periodic payment. Circa 21% of respondents were to some extent unlikely to behave according to the presented intention, while the remaining 22% of survey respondents could not decide.

Figure 5.7.6: Frequencies for Intention to travel more overall



Commuting Intentions

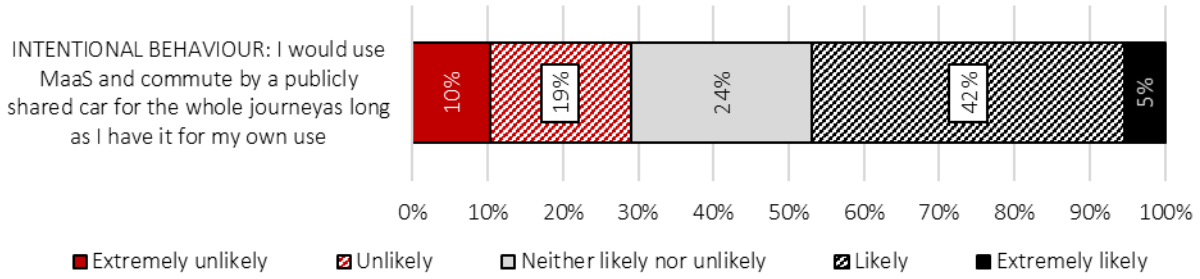
There were three intentional statements related to commuting that were also tested in this scientific inquiry, namely the intention *"I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use",* the intention *"I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know",* and the intention *"I would use MaaS and commute by public transport combined with other transport options",* for which all 427 respondents provided their intended likelihood of acting accordingly. As evident from Table 5.7.7, the mean for the intentional statement *"I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use"* achieved a value of 3.13, meaning survey respondents were on average likely to intend to commute by publicly shared cars for individual use, as 3 for the intentional Likert-scale statements stands for "Neither Likely nor Unlikely "and 4 stands for "Likely".

Table 5.7.7: Mean and SD for Intention to commute by publicly shared car for individual use

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use	427	1	0	3.13	1.103

As evident from Figure 5.7.7, almost 47% of survey respondents were likely or extremely likely to commute by publicly shared cars for individual use. As many as 24% of respondents could not make a decision regarding the likelihood of adopting the studied intention, while the remaining 29% were to some extent unlikely to behave according to the intentional statement being observed.

Figure 5.7.7: Frequencies for Intention to commute by publicly shared car for individual use



What is interesting to see is what commuting modes transport users would substitute with publicly shared car for individual use. According to Table 5.7.8, as many as 44% of all active travellers, or those who either walk or cycle to their most frequent destination, are either likely or extremely likely to substitute their current transport mode with publicly shared car for individual use. The same applied for 45% of private car drivers and 50% of unimodal public transport users. Moreover, 50% of those who previously combined public cars with public transport would switch to unimodal publicly shared car-based commute be MaaS available to them.

Table 5.7.8: Potential Switch from Current Mode to Publicly Shared Car for Individual Use

Current Commute Mode of Transport	Unlikely or Extremely Unlikely		Neither likely nor unlikely		Likely or Extremely Likely		Total
Active	29	32%	22	24%	40	44%	91
Private Car Passenger	3	17%	8	44%	7	39%	18
Private Car Driver	65	35%	37	20%	84	45%	186
Private Car with Public Transport	2	17%	2	17%	8	67%	12
Public Transport	23	22%	30	29%	52	50%	105
Public Transport with Public Car	0	0%	4	50%	4	50%	8
Public Car	2	29%	0	0%	5	71%	7
TOTAL							427

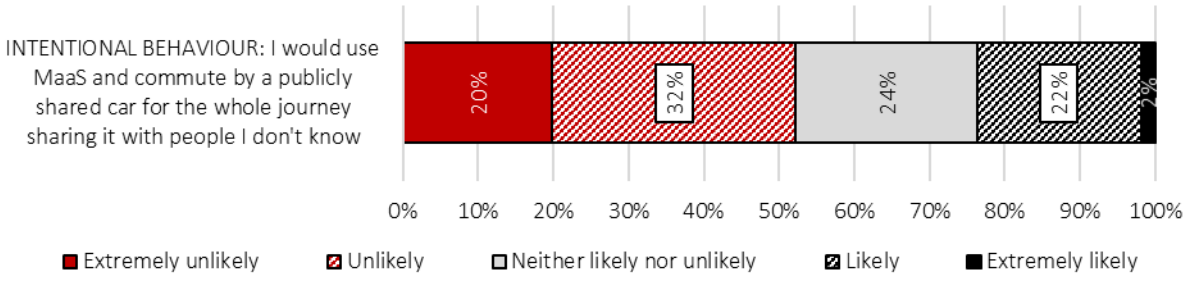
According to Table 5.7.9, the mean for the studied intentional Likert-scale statement *"I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know"* achieved a value of 2.53, meaning survey respondents were on average unlikely to intend to commute by public car shared with strangers, as 2 for the intentional Likert-scale statements stands for "Unlikely "and 3 stands for "Neither Likely nor Unlikely".

Table 5.7.9: Mean and SD for Intention to commute by public car shared with strangers

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know	427	1	0	2.53	1.094

As evident from Figure 5.7.8, only 24% of all survey respondents were to some extent likely to commute by publicly cars shared with strangers. More than a half, or 52%, were unlikely or extremely unlikely to adopt the studied intention, while the remaining 24% of respondents could not make a decision regarding the latter.

Figure 5.7.8: Frequencies for Intention to commute by public car shared with strangers



As for the shift from current transport mode, as many as 21% of active travellers are to some extent likely to choose collectively shared cars for their commute in place of their current mode of transport, as per Table 5.7.10. A total of 20% of private car drivers were to some extent likely to do the latter. Public transport users and those combining their personal car with public transport for their commute were among the ones most interested in substituting their current travel with the mode proposed herein.

Table 5.7.10: Potential Switch from Current Mode to Public Car shared with Strangers

Current Commute Mode of Transport	Unlikely or Extremely Unlikely		Neither likely nor unlikely		Likely or Extremely Likely		Total
Active	50	55%	22	24%	19	21%	91
Private Car Passenger	9	50%	3	17%	6	33%	18
Private Car Driver	109	59%	40	22%	37	20%	186
Private Car with Public Transport	6	50%	1	8%	5	42%	12
Public Transport	42	40%	30	29%	33	31%	105
Public Transport with Public Car	4	50%	3	38%	1	13%	8
Public Car	3	43%	4	57%	0	0%	7
TOTAL							427

As presented in Table 5.7.11, the mean for the intentional Likert-scale statement *"I would use MaaS and commute by public transport combined with other transport options"* achieved a value of 3.26,

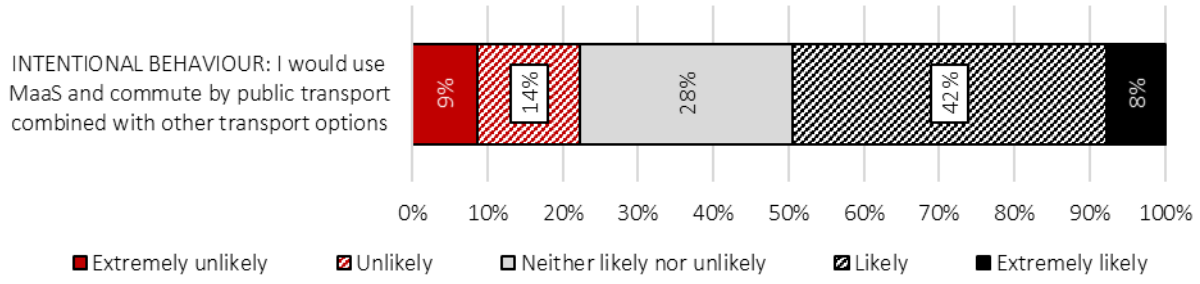
meaning survey respondents were on average likely to intend to behave according to the statement, as 3 for the intentional Likert-scale statements stands for "Neither Likely nor Unlikely "and 4 stands for "Likely".

Table 5.7.11: Mean and SD for Intention to commute by public transport combined with other modes

INTENTIONAL BEHAVIOUR	N	Min	Max	Mean	SD
I would use MaaS and commute by public transport combined with other transport options	427	1	5	3.26	1.069

As shown on Figure 5.7.9, a half of all survey respondents were likely or extremely likely to commute by public transport combined with other transport options when equipped with MaaS. Though, almost 23% of survey respondents stated they were either extremely unlikely or unlikely to adopt the studied intention, while the rest remained neutral towards the statement.

Figure 5.7.9: Frequencies for Intention to commute by public transport combined with other modes



As evident from Table 5.7.12, multimodal travellers, public transport users, private car passengers, and active travellers were the ones most interested in using public transport based multimodal MaaS offering for their commute. Private car drivers were the least interested in using public transport-based multimodal offer for their regular commute; yet, as many as 37% of private car drivers showed an interest in using the proposed mode of transport.

Table 5.7.12: Potential Switch from Current Mode to Public Transport combined with other options

Current Commute Mode of Transport	Unlikely or Extremely Unlikely		Neither likely nor un-likely		Likely or Extremely Likely		Total
Active	18	20%	23	25%	50	55%	91
Private Car Passenger	3	17%	5	28%	10	56%	18
Private Car Driver	60	32%	57	31%	69	37%	186
Private Car with Public Transport	0	0%	4	33%	8	67%	12
Public Transport	12	11%	29	28%	64	61%	105
Public Transport with Public Car	0	0%	2	25%	6	75%	8
Public Car	2	29%	1	14%	4	57%	7
TOTAL							427

Factor One: Added Value

This section of the chapter discusses the seven variables loading on the defined through EFA first factor, or construct, titled "Added Value". All 427 survey participants provided their level of agreement with each of the loading on the factor Likert-scale attitudinal statements. The average responses for the statements, as presented in Table 5.7.13, were marginally positive, falling above the value of 3 standing for "Neither Agree nor Disagree" but below the value of 4 standing for "Agree". The highest positive response referred to the Likert-scale statement IV_31 *"I would use MaaS if it offered me a more frequent and flexible public transport service day and night",* which achieved a mean value of 3.99, and the lowest positive response referred to the Likert-scale statement IV_29 *"I would use MaaS if I was informed about my contribution to reducing carbon footprint"*, which achieved a mean value of 3.44.

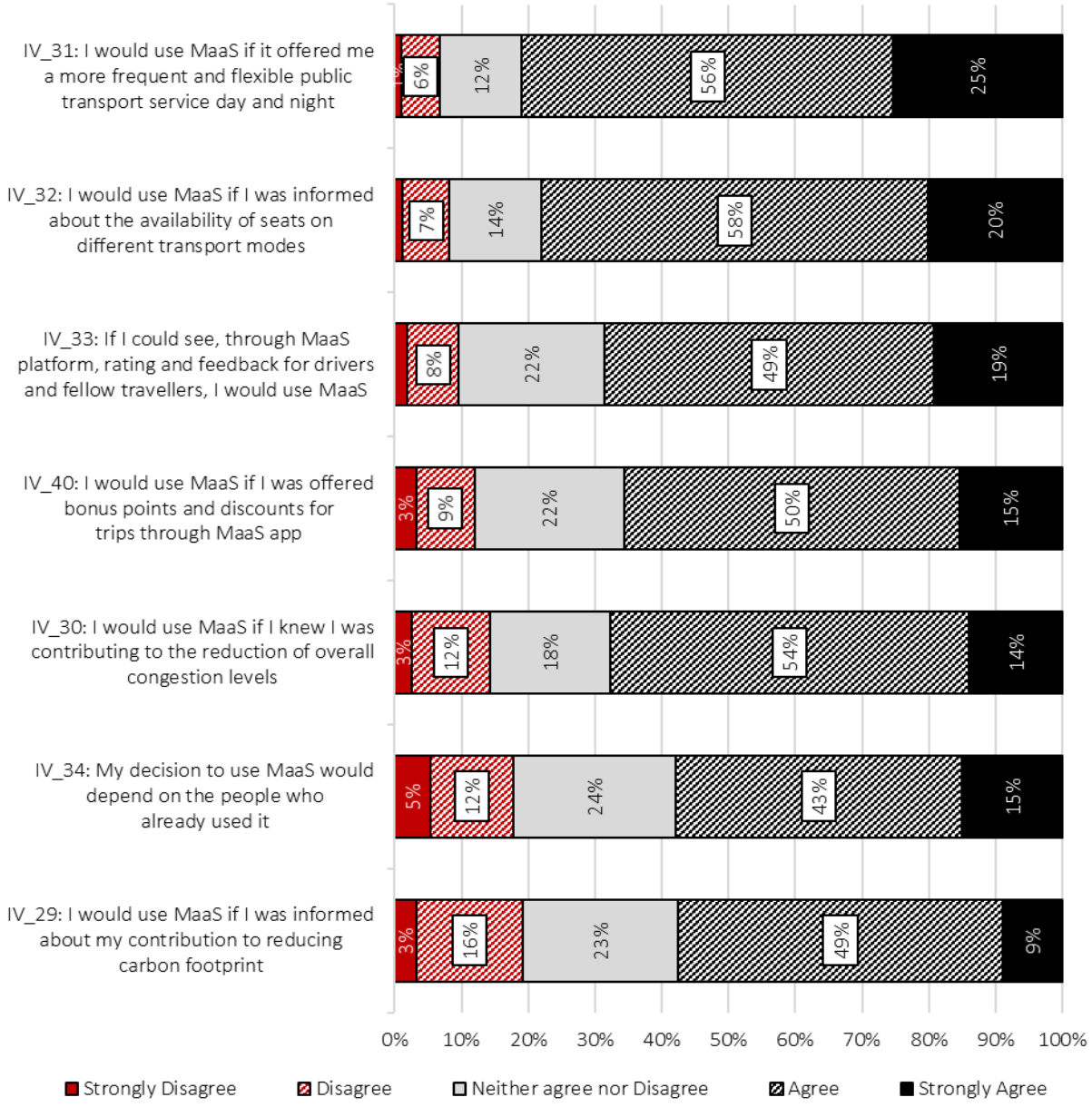
Table 5.7.13: Mean and SD for FACTOR 1 – ADDED VALUE

Variable	N	Min	Max	Mean	SD
IV_31: I would use MaaS if it offered me a more frequent and flexible public transport service day and night	427	1	5	3.99	0.833
IV_32: I would use MaaS if I was informed about the availability of seats on different transport modes	427	1	5	3.89	0.846
IV_33: If I could see, through MaaS platform, rating and feedback for drivers and fellow travellers, I would use MaaS	427	1	5	3.76	0.913
IV_40: I would use MaaS if I was offered bonus points and discounts for trips through MaaS app	427	1	5	3.66	0.952
IV_30: I would use MaaS if I knew I was contributing to the reduction of overall congestion levels	427	1	5	3.65	0.949
IV_34: My decision to use MaaS would depend on the people who already used it	427	1	5	3.50	1.060
IV_29: I would use MaaS if I was informed about my contribution to reducing carbon footprint	427	1	5	3.44	0.970

As evident from Figure 5.7.10, a total of 81% of survey respondents agreed or strongly agreed that a more flexible and frequent public transport service would have a positive influence on their decision to use MaaS. Only 7% of participants did not consider the latter an influential factor for MaaS use, while another 12% remained neutral. Getting information regarding the availability of seats on different transport modes was an influential factor for 78% of survey respondents. Around 14% of survey respondents could not decide whether the latter would influence their decision, while the remaining 8% to some extent disagreed with the statement. As many as 68% of transport users based in the UK to some extent agreed that getting feedback for drivers and fellow travellers via MaaS platform would make them more likely to use MaaS. Though, only 10% disagreed that such feature would influence their decision, while 22% could not decide. Receiving discounts and

bonus points via MaaS platform appeared an influential factor for 65% of respondents, but could not influence the remaining respondents, with 22% unable to decide and the rest disagreeing with the statement. A total of 68% of respondents would be interested in using MaaS if they could contribute to the reduction of overall congestion levels. Though, around 14% of respondents did not consider contributing to reduction of congestion a driver for their decision to use MaaS, while the rest remained neutral. Public opinion and suggestions of significant others could have an impact on the decision to use MaaS for 58% of respondents. Almost 17% of respondents, however, disagreed with the statement, while the rest could not decide. Last but not least, 58% of respondents also agreed that contributing to carbon footprint reduction would be a feature that would drive them towards using MaaS. As many as 19% of respondents, though, stated it would not impact their decision, and even more, or 23% of respondents, could not decide.

Figure 5.7.10: Overview of FACTOR 1 – ADDED VALUE



Factor Two: Car Use Convenience and Enjoyment

The six variables loading on the defined through EFA second factor, or construct, titled "Car Use Convenience and Enjoyment" are discussed in this section of the chapter. Again, all 427 survey participants provided their level of agreement with each of the loading on the factor Likert-scale attitudinal statements, with the means for all responses achieving values above 3, or "Neither Agree nor Disagree", and thus falling towards agreement, as shown in Table 5.7.14. On the scale where 3 stands for "Neither Agree nor Disagree", 4 stands for "Agree" and 5 stands for "Strongly Agree" the highest positive response referred to the Likert-scale statement IV_03 *"I travel by car because I can carry luggage/shopping/all the things I need without hassle",* which achieved a mean value of 4.21, and the lowest positive response referred to the Likert-scale statement IV_05 *"I travel by car because I feel safe this way"*, which achieved a mean value of 3.47.

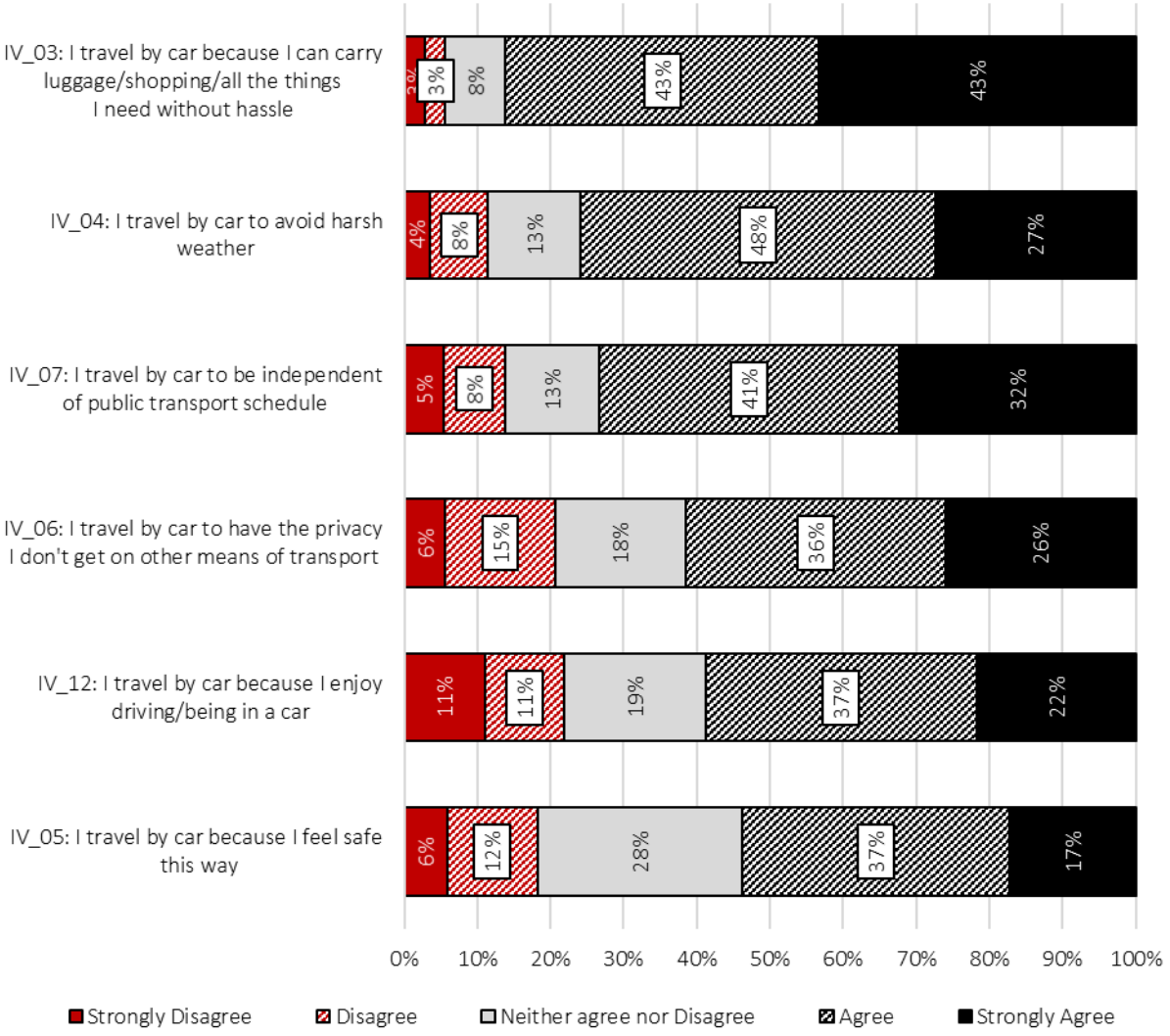
Table 5.7.14: Mean and SD for FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT

Variable	N	Min	Max	Mean	SD
IV_03: I travel by car because I can carry luggage/shopping/all the things I need without hassle	427	1	5	4.21	0.915
IV_04: I travel by car to avoid harsh weather	427	1	5	3.88	1.012
IV_07: I travel by car to be independent of public transport schedule	427	1	5	3.86	1.122
IV_06: I travel by car to have the privacy I don't get on other means of transport	427	1	5	3.61	1.182
IV_12: I travel by car because I enjoy driving/being in a car	427	1	5	3.48	1.251
IV_05: I travel by car because I feel safe this way	427	1	5	3.47	1.095

Thus, according to Figure 5.7.11, as many as 86% of survey respondents agreed that the ability to carry luggage, shopping and other things with ease was the main driver behind their use of car. Only 6% of respondents disagreed with the statement while another 8% remained neutral. The second most important reason to use a car was the ability to avoid harsh weather with circa 75% of survey respondent agreeing or strongly agreeing, 12% to some extent disagreeing with, and 13% remaining neutral towards the related Likert-scale statement. Yet another important driving factor to use a car was the desire to be independent of public transport schedule: as many as 73% of survey respondents agreed with the related Likert-scale statement, while 13% disagreed, and the rest remained neutral. A total of 62% of respondents to some extent agreed that the reason to travel by car was the privacy that other means of transport could not offer. The privacy was not the reason to travel by car for almost 21% of respondents, with the rest remaining neutral. More than a half of respondents, or 59%, agreed they simply enjoyed using a car, whether as a driver or a passenger. The latter, however, was not the reason for choosing a car for 22% of respondents,

with the rest remaining neutral. The last, yet important, reason to rely on a car was the safety provided, with 54% of respondents to some extent agreeing with the latter. Yet, as many as 28% of survey respondents could not decide whether a car was a safer travel option, while another 18% of respondents disagreed with such notion.

Figure 5.7.11: Overview of FACTOR 2 - CAR USE CONVENIENCE AND ENJOYMENT



Factor Three: Human Element Externalities

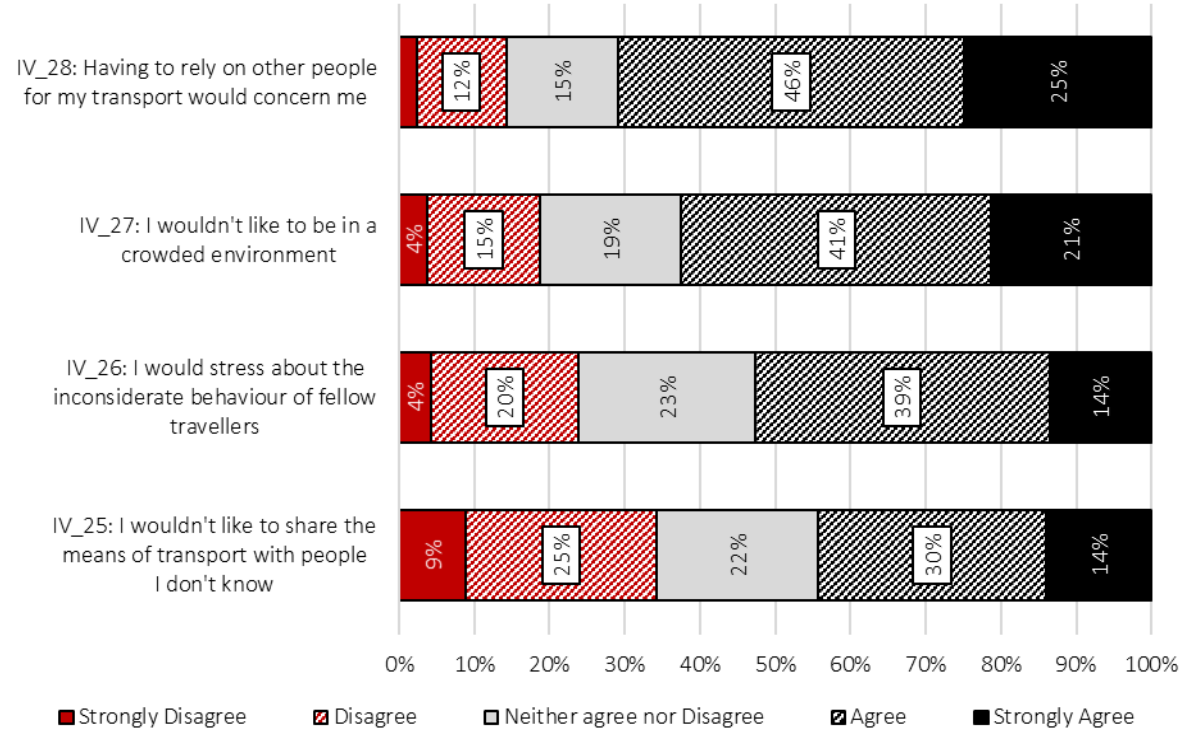
This section discusses the four variables loading on the defined through EFA third factor, titled "Human Element Externalities". The responses of 427 survey participants all achieved mean values falling towards agreement, as again all exceeded the value of 3 which stands for "Neither Agree nor Disagree", but did not exceed the value of 4 which stands for "Agree". The specific means for each Likert-scale attitudinal statement are presented in Table 5.7.15. The highest positive response referring to the Likert-scale statement IV_28 *"Having to rely on other people for my transport would concern me"* achieved a mean value of 3.79, and the lowest positive response referring to the Likert-scale statement IV_25 *"I wouldn't like to share the means of transport with people I don't know"* achieved a mean value of 3.15.

Table 5.7.15: Mean and SD for FACTOR 3 - HUMAN ELEMENT EXTERNALITIES

Variable	N	Min	Max	Mean	SD
IV_28: Having to rely on other people for my transport would concern me	427	1	5	3.79	1.021
IV_27: I wouldn't like to be in a crowded environment	427	1	5	3.61	1.091
IV_26: I would stress about the inconsiderate behaviour of fellow travellers	427	1	5	3.38	1.076
IV_25: I wouldn't like to share the means of transport with people I don't know	427	1	5	3.15	1.206

According to Figure 5.7.12 as many as 71% of survey respondents agreed or strongly agreed that having to rely on other people to provide transportation services would still concern them in the MaaS era. The latter, however, was not of concern for almost 14% of respondents, while 15% could not decide. As many as 62% of respondents agreed that facing the crowd on shared transport means would make them reluctant to travel with MaaS. Another 19%, though, were not concerned with the latter, and the rest remained neutral. More than a half, that is 53% of survey respondents demonstrated some level of agreement with the statement regarding the inconsiderate behaviour of fellow travellers being an obstacle to MaaS travel. As many as 23% of respondents could not decide whether the latter would impact their decision to use MaaS, and the remaining 24% disagreed with the statement. A total of 44% of survey respondents to some extent agreed that yet another issue they would be concerned about when travelling with MaaS was sharing the means of transport with strangers. Circa 34% of respondents did not consider the latter an issue, and the remaining 22% could not decide.

Figure 5.7.12: Overview of FACTOR 3 - HUMAN ELEMENT EXTERNALITIES



Factor Four: Trust in Functionality

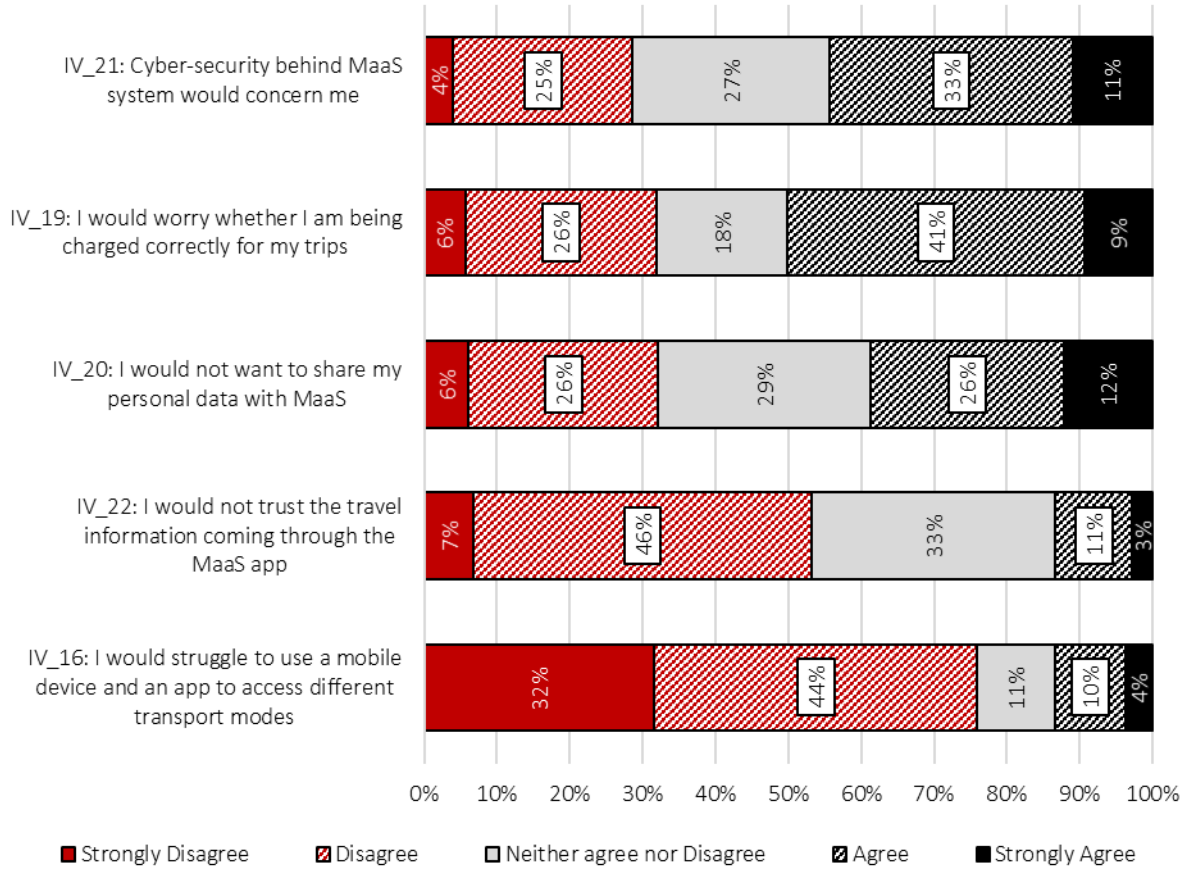
This section of the chapter discusses the five variables loading on the defined through EFA fourth factor titled "Trust in Functionality". A full sample of 427 participants provided their level of agreement with each of the loading on the factor Likert-scale attitudinal statements. The means for the Likert-scale items, loading on the factor, were falling on both positive and negative sides as presented in Table 5.7.16. On the scale where 2 stands for "Disagree", 3 stands for "Neither Agree nor Disagree" and 4 stands for "Agree", the highest mean of 3.23 was achieved for the Likert-scale statement IV_21 *"Cyber-security behind MaaS system would concern me",* and the lowest mean of 2.10 for the Likert-scale statement IV_12 *"I would struggle to use a mobile device and an app to access different transport modes"*, meaning the sample generally disagreed with such notion.

Table 5.7.16: Mean and SD for FACTOR 4 – TRUST IN FUNCTIONALITY

Variable	N	Min	Max	Mean	SD
IV_21: Cyber-security behind MaaS system would concern me	427	1	5	3.23	1.063
IV_19: I would worry whether I am being charged correctly for my trips	427	1	5	3.22	1.106
IV_20: I would not want to share my personal data with MaaS	427	1	5	3.13	1.115
IV_22: I would not trust the travel information coming through the MaaS app	427	1	5	2.56	0.874
IV_16: I would struggle to use a mobile device and an app to access different transport modes	427	1	5	2.10	1.067

As can be seen on Figure 5.7.13, despite the Likert-scale attitudinal item achieving the highest mean, only 44% of survey respondents agreed that they would be concerned about the cyber-security behind MaaS system. Slightly less, that being 39%, of respondents actually disagreed with the statement, and as many as 27% of respondents remained neutral towards the issue. More survey respondents, or 50%, were actually worried about being charged incorrectly for their trips through MaaS. That, however, was not a concern for almost 32% of respondents, while the remaining 18% could not decide. A total of 38% of survey respondents were not willing to share their personal data with MaaS, while 32%, did not consider the latter an issue. Almost 30% of respondents, however, remained neutral. More than a half, or 53% of survey respondents disagreed to some extent with not being able to trust the travel information the MaaS system would provide. Though, the latter was an issue for almost 14% of respondents, while the remainder could not decide. As many as 76% of respondents disagreed that they would struggle to use a mobile device and an app to access different transport modes via MaaS system. Yet, there were 14% of respondents who considered the latter a challenge, while the rest remained neutral towards the statement.

Figure 5.7.13: Overview of FACTOR 4 – TRUST IN FUNCTIONALITY



Factor Five: Cost Incentives

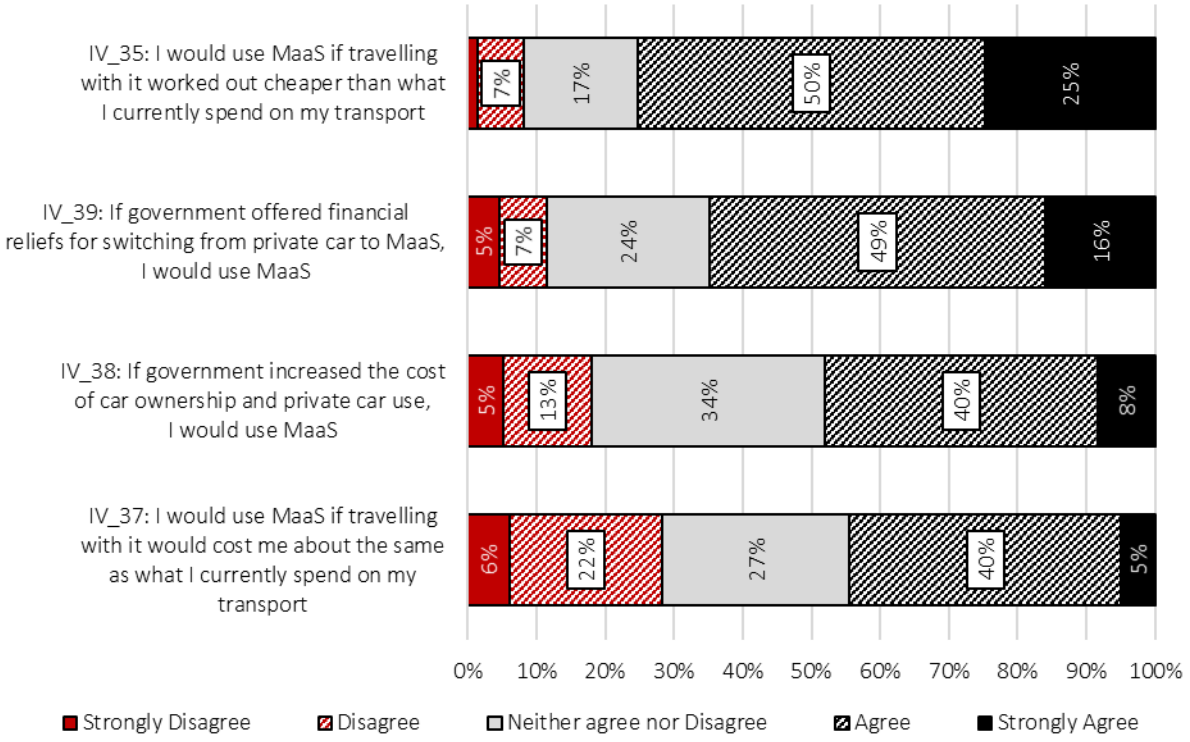
Here the four variables loading on the defined through EFA fifth factor titled "Cost Incentives" are discussed. All of the 427 survey respondents provided their level of agreement with each of the loading on the factor Likert-scale attitudinal statements. The means for the Likert-scale items, loading on the factor, were all falling between the values of 3 standing for "Neither Agree nor Disagree" and 4 standing for "Agree", as presented in Table 5.7.17. The highest mean of 3.90 was achieved for the Likert-scale statement IV_35 *"I would use MaaS if travelling with it worked out cheaper than what I currently spend on my transport",* and the lowest mean of 3.15 was achieved for the statement IV_37 *"I would use MaaS if travelling with it would cost me about the same as what I currently spend on my transport"*.

Table 5.7.17: Mean and SD for FACTOR 5 – COST INCENTIVES

Variable	N	Min	Max	Mean	SD
IV_35: I would use MaaS if travelling with it worked out cheaper than what I currently spend on my transport	427	1	5	3.90	0.897
IV_39: If government offered financial reliefs for switching from private car to MaaS, I would use MaaS	427	1	5	3.65	0.983
IV_38: If government increased the cost of car ownership and private car use, I would use MaaS	427	1	5	3.33	0.980
IV_37: I would use MaaS if travelling with it would cost me about the same as what I currently spend on my transport	427	1	5	3.15	1.019

Figure 5.7.14 shows that 75% of survey respondents agreed or strongly agreed with the Likert-scale statement with the highest mean, thus showing that being able to save on travelling would be a major cost related influence on their decision to use MaaS for travel. Only 8% of respondents disagreed that saving on travel would influence their decision to use MaaS, while 17% could not decide. Yet, 45% of survey respondents also agreed to some extent that they would use MaaS if its cost was about the same as their transport spending at present. The majority of respondents, however, either disagreed with or remained neutral towards the latter, with 28% and 27% responding accordingly. Getting financial reliefs from the government for switching from cars to MaaS appeared to have a positive influence on decision to use MaaS for 55% of survey respondents. As many as 24% of respondents, though, could not decide, while the rest disagreed with the statement. A total of 48% of survey respondents agreed that an increased cost of car ownership and use could potentially make them switch to MaaS, while 18% to some extent disagreed, and as many as 27% remained neutral.

Figure 5.7.14: Overview of FACTOR 5 – COST INCENTIVES



Factor Six: Car Use Morality

The sixth factor titled "Car Use Morality" had three Likert-scale attitudinal variables loading on it, with all 427 survey respondents having provided their level of agreement with each of the statements. Given the scale where 1 stands for "Strongly Disagree", 2 stands for "Disagree" and 3 stands for "Neither Agree nor Disagree", all the means for the Likert-scale items, loading on the factor, fell towards disagreement, as presented in Table 5.7.18. The highest mean of 2.21 was achieved for the Likert-scale statement IV_35 *"I think me using a car has little to do with climate change",* and the lowest mean of 1.66 was achieved for the Likert-scale statement IV_37 *"I think congestion is not an issue for the environment"*.

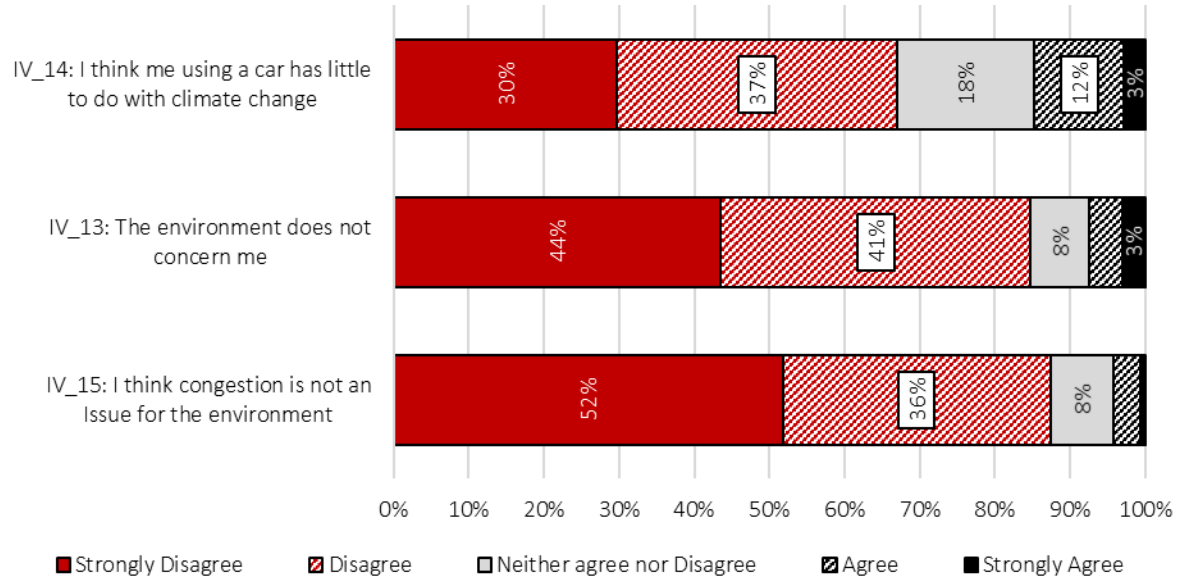
Table 5.7.18: Mean and SD for FACTOR 6 – CAR USE MORALITY

Variable	N	Min	Max	Mean	SD
IV_14: I think me using a car has little to do with climate change	427	1	5	2.21	1.082
IV_13: The environment does not concern me	427	1	5	1.82	0.967
IV_15: I think congestion is not an issue for the environment	427	1	5	1.66	0.831

By looking at Figure 5.7.15, it can be concluded that while 67% of survey respondents disagreed or strongly disagreed that their use of car had little to do with climate change, there were still 15% who actually agreed with such statement. Also, 18% could not decide what position they take. Even

more survey respondents, that being 85% disagreed or strongly disagreed that the environment is not their concern. Another 8%, however, remained neutral towards the statement, while the rest to some extent agreed the environment did not concern them. As many as 88% of respondents disagreed or strongly disagreed that the congestion, in their opinion, was not an issue for the environment. Only 4% of survey respondents agreed with such statement, while the remaining 8% could not decide on their opinion.

Figure 5.7.15: Overview of FACTOR 6 – CAR USE MORALITY



Factor Seven: Trust in Enabling Technology

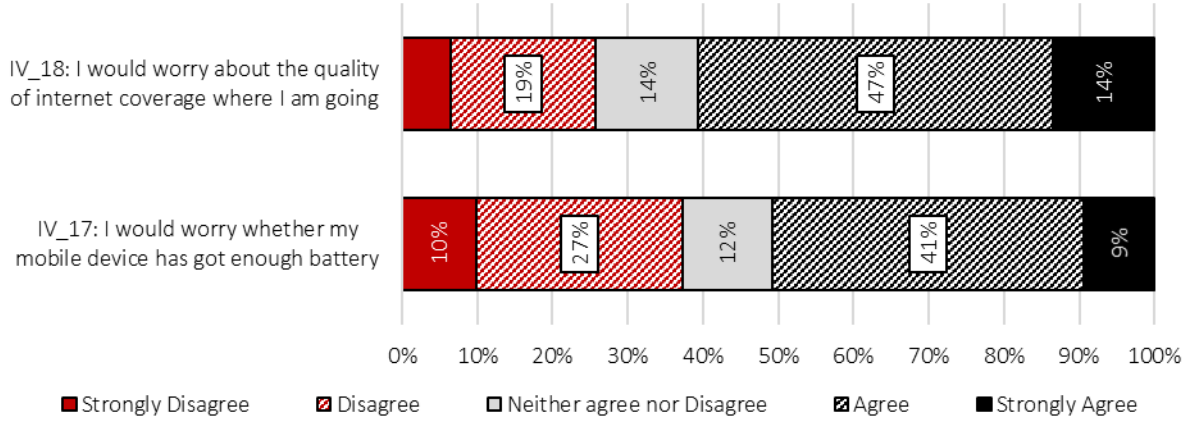
The seventh factor titled "Trust in Enabling Technology" had only two Likert-scale attitudinal variables loading on it. All 427 survey respondents provided their level of agreement with each of the statements. The means for both Likert-scale statements, as presented in Table 5.7.19, fell between the values of 3 standing for "Neither Agree nor Agree" and 4 standing for "Agree"; thus, survey participants generally agreed with the statements. The IV_18 *"I would worry about the quality of internet coverage where I am going"* achieved a mean value of 3.42, and the IV_17 *"I would worry whether my mobile device has got enough battery"* achieved a mean value of 3.13.

Table 5.7.19: Mean and SD for FACTOR 7 – TRUST IN TECHNOLOGY

Variable	N	Min	Max	Mean	SD
IV_18: I would worry about the quality of internet coverage where I am going	427	1	5	3.42	1.138
IV_17: I would worry whether my mobile device has got enough battery	427	1	5	3.13	1.201

As shown on Figure 5.7.16, 61% of participants to some extent agreed the quality of internet coverage would concern them when travelling with MaaS; another 14% remained neutral, whilst the remaining 25% to some extent disagreed internet coverage would be an issue. Half of all the survey respondents agreed that running out of battery on their mobile device would concern them when travelling with MaaS. As many as 37% of respondents, however, disagreed with the statement, while the rest could not decide.

Figure 5.7.16: Overview of FACTOR 7 – TRUST IN TECHNOLOGY



Factor Eight: Car Ownership Necessity

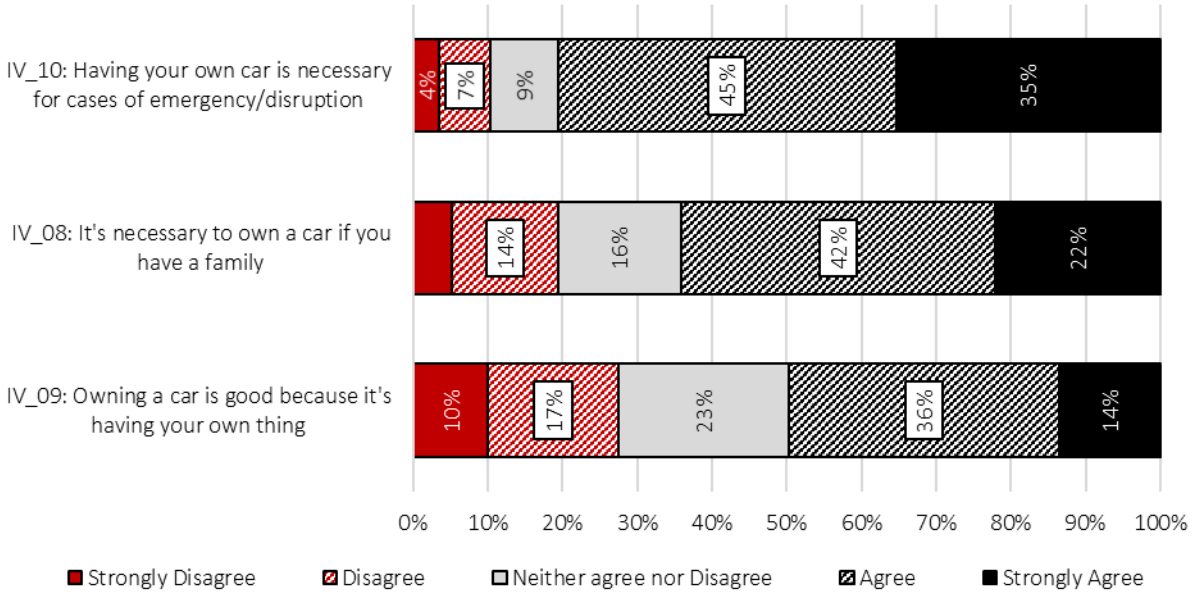
The three variables loading on the eighth factor titled "Car Ownership Necessity" are presented in this section of the chapter. All 427 survey respondents provided their level of agreement with each of the statements. According to Table 5.7.20, the means for the three Likert-scale statements generally fell towards agreement. The statement IV_10 *"Having your own car is necessary for cases of emergency/disruption"* achieved a mean value of 4.02, thus falling between the values of 4 standing for "Agree" and 5 standing for "Strongly agree". The statement IV_09 *"Owning a car is good because it's having your own thing"* achieved a mean value of 3.26, which was the lowest among the three.

Table 5.7.20: Mean and SD for FACTOR 8 - CAR OWNERSHIP NECESSITY

Variable	N	Min	Max	Mean	SD
IV_10: Having your own car is necessary for cases of emergency/disruption	427	1	5	4.02	1.017
IV_08: It's necessary to own a car if you have a family	427	1	5	3.62	1.129
IV_09: Owning a car is good because it's having your own thing	427	1	5	3.26	1.19

Figure 5.7.17 shows that 80% of survey respondents agreed or strongly agreed that owning a car was necessary for cases of emergency and disruption. Only 11% of respondents disagreed with the statement and another 9% could not decide. As many as 64% of survey respondents agreed owning a car was necessary when having a family. Almost 20% of respondents, however, disagreed with the latter, while 16% could neither agree nor disagree. Lastly, a half of all survey respondents agreed that having a car was good as it would be their own thing. For 27% of participants the latter, though, was not important, while the remaining 23% could not decide.

Figure 5.7.17: Overview of FACTOR 8 - CAR OWNERSHIP NECESSITY



5.8. Ordinal Logistic Regression Modelling

This section of the chapter presents the detailed analysis process and the results of ordinal logistic regression modelling. Six models studying the relationship of attitudinal factor variables, socio-demographic and past behaviour variables with the Intentional Likert-scale items were developed.

5.8.1. Analysis Process

First, in order to be used in ordinal logistic regression modelling, each of the factors generated through EFA had to be given a score. One of the simplest ways to compute factor scores for each of the survey respondents is *sum scores*, which, whilst preserving the variation in the original data, is about summing raw scores corresponding to all items loading on a factor (DiStefano et al., 2009). The sum scores method is desirable when the scales used for data collection are exploratory, not previously tested and, thus, have little evidence of reliability or validity (Hair et al, 2006), which suits particularly well the items tested in this quantitative inquiry. The number of items loading on each factor was different; therefore, the scores to each factor were given by calculating average (DiStefano et al., 2009), or *mean* (McNeish & Gordon Wolf, 2020), of all the items loading on each of the eight factors retained. As these new variables representing the factors were continuous, they were labelled as scale in IBM SPSS Statistics.

Next, the number of categories for some of the past behaviour items had to be reduced. As evident from Table 5.4.5 (p.142), for the item "Publicly shared car for my own use (Taxi/Uber/Zipcar/etc.)" there was only one survey respondent who reported daily use; only 18 respondents stated they used the observed transport option few times a week; only 25 respondents reported they used the option once a week. Because of the small size of these groups, the decision was made to retain only three response categories, those being *at least once a month*, *rarely*, and *never*, with all the responses from the *daily*, *few times a week*, and *once a week* categories moving to *at least once a month* category. The same approach was adopted for the "Public car shared with others (Taxi share/UberPool/BlaBlaCar/etc.)" transport option, with three daily use responses, seven responses reporting the use of the option several times a week, and 11 responses reporting the use of the option once a week added to the *at least once a month* category, and only three categories retained. When all the explanatory variables, those being the factors, past behaviour items and demographic features, were prepared, ordinal regression models were developed to quantify the relationship between those explanatory variables and the five intentional Likert-scale statements.

The modelling process was based on the idea that attitudes have more explanatory power over travel behavioural intentions than socio-demographic and past behaviour characteristics, in line with Anable (2005). Thus, for each intentional Likert-scale statement various models were generated by testing the same combination of factorial variables (i.e. attitudes), but socio-demographic and past behaviour variables are different in each model as only those resulting in significant prediction, with $p > 0.05$, were retained. The models were generated using PLUM procedure for ordinal logistic regression, embedded in IBM SPSS Statistics. It is important to note that, although all nine intentional Likert-scale statements went through experimental PLUM procedure, only six models are presented in the overview of findings (Section 5.8.2) as they fulfilled all the identified quantitative rigour criteria, while the remainder did not. It is also important to note that exploration of relationships between the explanatory variables themselves were not within the scale of this study; thus, only their correlations with the intentional Likert-scale items were investigated.

Each generated model was named after the studied intentional Likert-scale statement. For each of the models, a Parameter Estimates table was produced (Table 5.8.5, Table 5.8.10, Table 5.8.15, Table 5.8.20, Table 5.8.25, and Table 5.8.30), which is a core of the ordinal regression output in SPSS specifying the relationships between explanatory variables and the dependent variable. The Parameter Estimates tables included the figures for estimates, or β coefficients, accompanying standard errors, Wald Chi-square Test results and the associated significance levels, specified as the criteria for ensuring quantitative rigour of individual predictor, or explanatory, variables, and the 95% Confidence Intervals (CI) giving a range of plausible values for the parameter estimates (β). The outputs for Likelihood Ratio Chi-square Test, Pearson Chi-square test, Deviance statistics and Test of parallel lines, which were specified as criteria for models' quantitative rigour, were also generated, alongside the *pseudo*-R^2 statistics describing the strength of association among explanatory variables and the dependent variable. Only the best fit models, or the models achieving the strongest associations among explanatory variables and the studied dependent variables, i.e. with the highest *pseudo*-R^2 values, but also meeting the criteria for quantitative rigour, i.e. passing all the null hypothesis significance tests, were used for further statistical inferences.

In linear regression models the R^2 statistics are used to measure the proportion of the variation in the dependent variable explained by the explanatory variables in the model (Peng & So, 2010). For logistic regression models, however, pure R^2 measures cannot be obtained (Best & Wolf, 2015). A number of *pseudo*-R^2 measures exist for logistic regression models (Smith & McKenna, 2013),

which measure the strength of association of the explanatory variables with the dependent variable (Norusis, 2012). The *pseudo*-R^2 values for ordinal logistics regression models available through IBM SPSS Statistics software included Cox and Snell *pseudo*-R^2 with Nagelkerke correction as well as McFadden *pseudo*-R^2. Both statistics produced values between 0 and 1, with higher values suggesting higher association of explanatory variables with the dependent variable (Best & Wolf, 2015). In general, Cox and Snell *pseudo*-R^2 with Nagelkerke correction tends to give larger values than all other types of *pseudo*-R^2 (Best & Wolf, 2015) and also is one of the few statistics that produces values closest to those that could be obtained for linear regression models (Smith & McKenna, 2013). Therefore, models with higher values for Cox and Snell *pseudo*-R^2 with Nagelkerke correction were retained for statistical inferences.

5.8.2. Overview of Findings

This chapter subsection presents the detailed output for ordinal logistic regression modelling. For each model, the values for rigour criteria are presented and the numbers in Parameter Estimates Tables are interpreted.

Model One: Intention not to own a car

The base category tested for the set of independent variables in Model One was the intentional Likert-scale statement *"With MaaS I would consider not owning a car."* The developed for the statement ordinal regression model achieved statistical significance, with $p < 0.05$, for Likelihood Ratio Chi-square Test, presented in Table 5.8.1; therefore, the null hypothesis that the intercept model, or the model without predictors, is as good as the model with predictors, was rejected.

Table 5.8.1: Model One – Likelihood Ratio Chi-square Test

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1244.304			
Final	1032.435	211.869	14	0.000

As evident from Table 5.8.2, no statistical significance, with $p > 0.05$, was achieved for Pearson Chi-square Tests and Deviance statistics, suggesting good fit of the model to the data.

Table 5.8.2: Model One – Pearson Chi-square Test and Deviance Statistics

Statistics	Chi-Square	df	Sig.
Pearson	1635.219	1690	0.827
Deviance	1032.435	1690	1.000

The null hypothesis significance testing through the Test of Parallel Lines, presented in Table 5.8.3, also resulted in insignificant results, with p > 0.05, this way suggesting the categories in the model were parallel, and the ordinal logistic regression approach was a good fit to the collected data.

Table 5.8.3: Model One – Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1032.435			
General	986.340	46.095	42	0.307

This model was also the strongest of the six models developed, achieving the value of 0.414 for Cox and Snell pseudo-R^2 with Nagelkerke correction, as in Table 5.8.4, thus depicting good representation of the interaction among variables in the model.

Table 5.8.4: Model One – Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0.391
Nagelkerke	0.414
McFadden	0.17

The Parameter Estimates table, presented in Table 5.8.5, demonstrates that the intentional Likert-scale statement "With MaaS I would consider not owning a car" is significantly correlated with eight out of ten explanatory variables, as those eight variables achieved significance levels $p < 0.05$. Six of those predictors were the factorial variables generated via EFA, while another two were the past behaviour items. The eight explanatory variables exhibited both positive and negative regression coefficients.

The first factor "Added Value" was a significant predictor of the intention not to own a car when equipped with MaaS (*Wald* $x^2 = 13.766$ and $p < 0.001$). The estimate (β) for the factor was positive and achieved a value of 0.709 (*95% CI 0.335 to 1.084*), meaning that, given all of the other variables in the model are held constant, for every one unit increase on the factor "Added Value" there was a predicted increase of 0.709 in the odds of being more likely to intend not to own a car when equipped with MaaS.

The third factor "Human Element Externalities" was also a significant predictor of intention not to own a car with MaaS (*Wald* $x^2 = 6.164$ and $p < 0.05$). The factor, however, had a negative influence on the studied intention. Thus, the estimate (β) value of -0.318 (*95% CI -0.570 to -0.067*) meant that for a one unit increase on the factor "Human Element Externalities" there was a predicted

decrease of 0.318 in the odds of falling at a higher level of likelihood on the intention not to own a car with MaaS.

It could be hypothesised that the fourth factor "Trust in Functionality", which is another significant predictor in the model (*Wald* $x^2 = 20.046$ and $p < 0.001$), should have a negative influence on the intention not to own a car with MaaS. This model, however, suggests, with the estimate (β) being equal to 0.660 (*95% CI 0.371 to 0.950*), that for a one unit increase on the factor "Trust in Functionality" the odds of falling at a higher level of likelihood of adopting the studied intention also increased by 0.660. Going back to the qualitative findings, the established relationship could mean that the survey respondents, despite being concerned with cyber-security and efficiency issues, when agreeing not to own a car have no other choice but to rely on applications and share information to be able to go about their daily business.

The fifth factor "Cost Incentives" (*Wald* $x^2 = 20.944$ and $p < 0.001$), had the highest reported estimate (β) of 0.846 (*95% CI 0.484 to 1.209*), which means that for every one unit increase on the factor "Cost Incentives" there was a predicted increase of 0.846 in the odds of falling at a higher level of likelihood on the "With MaaS I would consider not owning a car" intentional variable.

The seventh factor "Trust in Enabling Technology", (Wald Chi-square = 4.038 and $p < 0.05$), achieved the estimate (β) of -0.199 (*95% CI -0.393 to-0.005*) meaning that for a one unit increase on the factor "Trust in Enabling Technology" there was an associated decrease of 0.199 in the odds of falling at a higher level of likelihood on the intention not to own a car. The last of the factorial significant predictors in the model was the eighth factor "Car Ownership Necessity" (*Wald* $x^2 = 27.383$ and $p < 0.001$), with the estimate (β) of -0.686 (*95% CI -0.943 to -0.429*) implying that for a one unit increase on the factor there was a predicted decrease of 0.686 in the odds of falling at a higher level of likelihood on the intention not to own a car.

Another two statistically significant explanatory variables referred to past behaviour and included "Car Ownership" (*Wald* $x^2 = 9.000$ and $p < 0.05$), and the daily use of private car as a driver (*Wald* $x^2 = 6.160$ and $p < 0.05$). So, as the estimate (β) for "Car Ownership" achieved a value of 0.816 (*95% CI 0.283 to 1.349*), there was a predicted increase of 0.816 in the odds of falling at a higher level of likelihood on the intention not to own a car for the survey respondents who did not own a car. For the survey respondents who used their car as a driver daily, as the estimate (β) for the variable achieved a value of -0.718 (*95% CI -1.285 to -0.151*), there was a predicted decrease of 0.718 in the odds of falling at a higher level of likelihood on the intention not to own a car with MaaS.

Table 5.8.5: Model One – Parameter Estimates for Intention not to own a car

Parameter		Estimate (β)	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
INTENTIONAL BEHAVIOUR: With MaaS I would consider not owning a car	*Extremely unlikely*	1.925	0.989	3.789	1.000	0.052	-0.013	3.863
	Unlikely	4.134	1.006	16.887	1.000	0.000	2.162	6.106
	Neither likely nor unlikely	5.453	1.018	28.724	1.000	0.000	3.459	7.448
	Likely	7.412	1.046	50.227	1.000	0.000	5.362	9.462
FACTOR 1: ADDED VALUE		0.709	0.191	13.766	1.000	**0.000**	0.335	1.084
FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT		0.062	0.142	0.189	1.000	0.664	-0.217	0.340
FACTOR 3: HUMAN ELEMENT EXTERNALITIES		-0.318	0.128	6.164	1.000	**0.013**	-0.570	-0.067
FACTOR 4: TRUST IN FUNCTIONALITY		0.660	0.148	20.046	1.000	**0.000**	0.371	0.950
FACTOR 5: COST INCENTIVES		0.846	0.185	20.944	1.000	**0.000**	0.484	1.209
FACTOR 6: CAR USE MORALITY		-0.023	0.135	0.029	1.000	0.865	-0.287	0.241
FACTOR 7: TRUST IN ENABLING TECHNOLOGY		-0.199	0.099	4.038	1.000	**0.044**	-0.393	-0.005
FACTOR 8: CAR OWNERSHIP NECESSITY		-0.686	0.131	27.383	1.000	**0.000**	-0.943	-0.429
CAR OWNERSHIP: Do you have a car in your household?	*No*	0.816	0.272	9.000	1.000	**0.003**	0.283	1.349
	Yes	0a	.	.	0.000	.	.	.
FREQUENCY OF CAR USE: Private car as a driver	*Daily*	-0.718	0.289	6.160	1.000	**0.013**	-1.285	-0.151
	Few times a week	0.109	0.306	0.126	1.000	0.722	-0.491	0.709
	Once a week	0.177	0.510	0.121	1.000	0.728	-0.822	1.177
	At least once a month	0.533	0.621	0.738	1.000	0.390	-0.683	1.750
	Rarely	0.348	0.313	1.233	1.000	0.267	-0.266	0.961
	Never	0a	.	.	0.000	.	.	.

Link function: Logit.

a This parameter is set to zero because it is redundant.

Model Two: Intention to replace public transport trips with publicly shared cars

The base category tested for the set of independent variables in Model Two was the intentional Likert-scale statement *"With MaaS I would replace some of my public transport trips with publicly shared cars."* Statistical significance for the Likelihood Ratio Chi-square Test, presented in Table 5.8.6, indicates that the null hypothesis for the developed model can be rejected, and that the model with predictors is better than the intercept model without predictors.

Table 5.8.6: Model Two – Likelihood Ratio Chi-square Test

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1160.385			
Final	973.276	187.109	17	0.000

No statistical significance, with $p > 0.05$, was achieved for Pearson Chi-square Tests and Deviance statistics, presented on Table 5.8.7, meaning the developed model fits the data well.

Table 5.8.7: Model Two – Pearson Chi-square Test and Deviance Statistics

Statistics	Chi-Square	df	Sig.
Pearson	1644.804	1687	0.765
Deviance	973.276	1687	1.000

The Test of Parallel Lines, presented on Table 5.8.8, also resulted in insignificant results, with $p > 0.05$, this way suggesting the categories in the model were parallel, and the ordinal logistic regression approach was a good fit to the data.

Table 5.8.8: Model Two – Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	973.276			
General	911.977	61.299	51	0.153

As shown on Table 5.8.9, the model achieved a value of 0.380 for Cox and Snell *pseudo*-R^2 with Nagelkerke correction, thus depicting good interaction among variables in the model.

Table 5.8.9: Model Two – Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0.355
Nagelkerke	0.38
McFadden	0.161

Table 5.8.10 presents the Parameter Estimates table for the intentional Likert-scale statement "With MaaS I would replace some of my public transport trips with publicly shared cars". The intention tends to be significantly correlated, as $p < 0.05$, with seven out of eleven explanatory variables used in the analysis. Four of those significant predictor variables were the EFA generated factors, while another three were the past behaviour items. The seven explanatory variables exhibited both positive and negative regression coefficients.

Similar to the previous model, the first factor "Added Value" was a significant predictor also of the intention "With MaaS I would replace some of my public transport trips with publicly shared cars" (*Wald* $x^2 = 20.530$ and $p < 0.001$). The estimate (β) for the factor achieved a value of 0.860 (*95% CI 0.488 to 1.232*), meaning that for a one unit increase on the factor "Added Value" there was a predicted increase of 0.860 on the intention to replace public transport trips with publicly shared cars when equipped with MaaS.

The second factor "Car Use Convenience and Enjoyment", unlike in the previous model, appeared a significant predictor of the studied intention to replace public transport trips with publicly shared cars when equipped with MaaS (*Wald* $x^2 = 9.610$ and $p < 0.05$). The estimate (β) value of 0.450 *(95% CI 0.166 to 0.735)* meant that for a one unit increase on the factor "Car Use Convenience and Enjoyment" there was a predicted increase of 0.450 in the odds of falling at a higher level on the intention to replace public transport trips with publicly shared cars when equipped with MaaS.

The third factor "Human Element Externalities" was also a significant predictor in the model (*Wald* $x^2 = 17.484$ and $p < 0.05$), and had an even stronger than in the previous model negative influence on the studied intention. Thus, the estimate (β) value of -0.581 (*95% CI -0.853 to -0.309*) meant that for a one unit increase on the factor "Human Element Externalities" there was a predicted decrease of 0.581 in the odds of falling at a higher level on the studied intention.

The fifth factor "Cost Incentives" (*Wald* $x^2 = 7.908$ and $p < 0.05$) had the estimate (β) of 0.513 (*95% CI 0.155 to 0.870*), which means that for every one unit increase on the factor "Cost Incentives" there was a predicted increase of 0.513 in the odds of falling at a higher level of likelihood on the studied intentional variable.

The last three statistically significant explanatory variables in this model also referred to past behaviour and included the use of public transport once a week, (*Wald* $x^2 = 11.300$ and $p < 0.001$), as well as monthly use of publicly shared car on individual basis (*Wald* $x^2 = 4.121$ and $p < 0.05$), and

previous use of public cars for collective sharing for monthly (*Wald* $x^2 = 6.023$ and $p < 0.05$) and for rare (*Wald* $x^2 = 6.321$ and $p < 0.05$) use. So, there was a predicted increase of 1.477 (*95% CI 0.616 to 2.339*), which was the highest estimate (β) in the model, in the likelihood of adopting the intention to replace public transport trips with publicly shared cars for the respondents who used public transport only once a week. For the survey respondents who used publicly shared cars on individual basis at least once a month there was a predicted increase of 0.532 (*95% CI 0.018 to 1.045*) in the likelihood of adopting the intention to replace public transport trips with publicly shared cars when equipped with MaaS. Finally, for those respondents who used public cars for collective sharing at least once a month the estimate (β) achieved a value of 0.806 (*95% CI 0.162 to 1.449*), meaning there was a predicted increase of 0.806 in the likelihood of adopting the studied intention, while for those who rarely used collectively shared public cars the increase in the likelihood to adopt the studied intention, according to the estimate (β), was 0.666 (*95% CI 0.147 to 1.184*).

Table 5.8.10: Model Two - Parameter Estimates for Intention to replace public transport trips with publicly shared cars

Parameter		Estimate (β)	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
INTENTIONAL BEHAVIOUR: With MaaS I would replace some of my public transport trips with publicly shared cars	*Extremely unlikely*	1.655	1.019	2.638	1.000	0.104	-0.342	3.653
	Unlikely	3.169	1.027	9.514	1.000	0.002	1.155	5.183
	Neither likely nor unlikely	4.614	1.040	19.665	1.000	0.000	2.575	6.653
	Likely	8.009	1.081	54.878	1.000	0.000	5.890	10.128
FACTOR 1: ADDED VALUE		0.860	0.190	20.530	1.000	**0.000**	0.488	1.232
FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT		0.450	0.145	9.610	1.000	**0.002**	0.166	0.735
FACTOR 3: HUMAN ELEMENT EXTERNALITIES		-0.581	0.139	17.484	1.000	**0.000**	-0.853	-0.309
FACTOR 4: TRUST IN FUNCTIONALITY		-0.045	0.150	0.091	1.000	0.763	-0.339	0.248
FACTOR 5: COST INCENTIVES		0.513	0.182	7.908	1.000	**0.005**	0.155	0.870
FACTOR 6: CAR USE MORALITY		0.014	0.136	0.011	1.000	0.918	-0.253	0.282
FACTOR 7: TRUST IN ENABLING TECHNOLOGY		-0.152	0.103	2.175	1.000	0.140	-0.354	0.050
FACTOR 8: CAR OWNERSHIP NECESSITY		0.058	0.130	0.199	1.000	0.655	-0.197	0.312
FREQUENCY OF PT USE: Public Transport Bus/Tram/Train/etc.	*Daily*	0.690	0.405	2.896	1.000	0.089	-0.105	1.485
	Few times a week	-0.327	0.372	0.773	1.000	0.379	-1.055	0.402
	Once a week	1.477	0.440	11.300	1.000	**0.001**	0.616	2.339
	At least once a month	0.155	0.375	0.170	1.000	0.680	-0.581	0.890
	Rarely	0.550	0.342	2.589	1.000	0.108	-0.120	1.221
	Never	0a	.	.	0.000	.	.	.
FREQUENCY OF CAR USE: Publicly shared car for my own use (Taxi/ Uber/Zipcar/ etc.)	*At least once a month*	0.532	0.262	4.121	1.000	**0.042**	0.018	1.045
	Rarely	-0.161	0.248	0.417	1.000	0.518	-0.647	0.326
	Never	0a	.	.	0.000	.	.	.
FREQUENCY OF CAR USE: Public car shared with others (Taxi share/ UberPool/BlaBlaCar/etc.)	*At least once a month*	0.806	0.328	6.023	1.000	**0.014**	0.162	1.449
	Rarely	0.666	0.265	6.321	1.000	**0.012**	0.147	1.184
	Never	0a	.	.	0.000	.	.	.

Link function: Logit.

a This parameter is set to zero because it is redundant.

Model Three: Intention to commute by publicly shared car for individual use

The base category tested for the set of independent variables in Model Three was the intentional Likert-scale statement *"I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use."* The developed for the statement ordinal logistic regression model achieved statistical significance, with $p < 0.05$, for Likelihood Ratio Chi-square Test, presented in Table 5.8.11; therefore, the null hypothesis that the intercept model, or the model without predictors, is as good as the model with predictors, was rejected.

Table 5.8.11: Model Three – Likelihood Ratio Chi-square Test

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1207.017			
Final	1100.359	106.658	10	0.000

As evident from Table 5.8.12, no statistical significance, with $p > 0.05$, was achieved for Pearson Chi-square Tests and Deviance statistics, suggesting good fit of the model to the data.

Table 5.8.12: Model Three – Pearson Chi-square Test and Deviance Statistics

Statistics	Chi-Square	df	Sig.
Pearson	1787.748	1694	0.056
Deviance	1100.359	1694	1.000

The null hypothesis significance testing through the Test of Parallel Lines, presented on Table 5.8.13, also resulted in insignificant results, with $p > 0.05$, this way suggesting the categories in the model were parallel, and the ordinal logistic regression approach was a good fit to the collected data.

Table 5.8.13: Model Three – Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1100.359			
General	1067.8	32.559	30	0.342

The model, though, according to Table 5.8.14, achieved the lowest among the six developed models value for Cox and Snell pseudo-R^2 with Nagelkerke correction, equal to 0.235, thus depicting a lower than in the other models association of explanatory variables with the studied intention, yet proving such association exists.

Table 5.8.14: Model Three - Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0.221
Nagelkerke	0.235
McFadden	0.088

Table 5.8.15 presents the Parameter Estimates table for the intentional Likert-scale statement "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use". The studied intentional Likert-scale statement tends to be significantly correlated with five out of nine explanatory variables employed in the ordinal logistic regression model as their significance $p < 0.05$, Four of those significant predictor variables were the EFA generated factors, while the fifth one referred to one of the past behaviour survey items. All the variables with significant correlations affect the studied intention positively.

So, the factor titled "Cost Incentives" appeared to be a significant (*Wald* $x^2 = 22.808$ and $p < 0.001$), but also the most powerful predictor of the intention "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use" as the estimate (β) for the factor achieved a value of 0.841 (*95% CI 0.496 to 1.186*). The latter implied that for a one unit increase on the factor "Cost Incentives" there was a predicted increase of 0.841 in the odds of adopting the intention to commute by publicly shared cars for individual use when equipped with MaaS.

In this model, like in the previous ones, the factor titled "Added Value" was also a significant predictor of the studied intention (*Wald* $x^2 = 12.935$ and $p < 0.001$). As the estimate (β) for the factor achieved a value of 0.642 (*95% CI 0.292 to 0.992*), the odds of survey respondents adopting the intention "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use" increased by 0.642 for every one unit increase on the factor "Added Value".

The factor "Car Use Convenience and Enjoyment" appeared a predictor of the studied intention to commute by publicly shared cars for individual use when equipped with MaaS that was very closely approaching the set for this quantitative inquiry significance value benchmark of 0.05 (*Wald* $x^2 = 3.654$ and $0.05 < p < 0.06$). The estimate (β) value of 0.265 meant that for a one unit increase on the factor "Car Use Convenience and Enjoyment" there was a predicted increase of 0.265 in the odds of falling at a higher level on the intention to commute by publicly shared cars for individual

use when equipped with MaaS; the 95% CI ranging from -0.007 to 0.536, however, implies a possibility of negative association of the factor with the dependent variable.

Another significant factorial explanatory variable in the model was "Car Use Morality" (*Wald* x^2 = *11.358* and $p < 0.05$). The estimate (β) value of 0.450 (*95% CI 0.188 to 0.711*) meant that for a one unit increase on the factor "Lack of Morality" there was a predicted increase of 0.450 in the odds of falling at a higher level on the intention "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use".

The last statistically significant explanatory variable in this model again referred to past behaviour and included the use of publicly shared car on individual basis at least once a month (*Wald* x^2 = *3.875* and $p < 0.05$). So, according to the estimate (β), there was a predicted increase of 0.452 (*95% CI 0.002 to 0.903*) in the likelihood of adopting the intention to commute by publicly shared car for individual use when equipped with MaaS for the respondents who used publicly shared cars on individual basis at least once a month.

Table 5.8.15: Model Three - Parameter Estimates for Intention to commute by publicly shared car for individual use

Parameter		Estimate (β)	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
INTENTIONAL BEHAVIOUR: I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use	*Extremely unlikely*	5.027	0.964	27.170	1.000	0.000	3.137	6.917
	Unlikely	6.517	0.981	44.104	1.000	0.000	4.594	8.440
	Neither likely nor unlikely	7.752	1.001	59.959	1.000	0.000	5.790	9.715
	Likely	10.823	1.060	104.288	1.000	0.000	8.746	12.900
FACTOR 1: ADDED VALUE		0.642	0.178	12.935	1.000	**0.000**	0.292	0.992
FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT		0.265	0.138	3.654	1.000	**0.056**	-0.007	0.536
FACTOR 3: HUMAN ELEMENT EXTERNALITIES		0.229	0.127	3.243	1.000	0.072	-0.020	0.477
FACTOR 4: TRUST IN FUNCTIONALITY		-0.101	0.142	0.503	1.000	0.478	-0.379	0.178
FACTOR 5: COST INCENTIVES		0.841	0.176	22.808	1.000	**0.000**	0.496	1.186
FACTOR 6: CAR USE MORALITY		0.450	0.133	11.358	1.000	**0.001**	0.188	0.711
FACTOR 7: TRUST IN ENABLING TECHNOLOGY		-0.156	0.097	2.556	1.000	0.110	-0.346	0.035
FACTOR 8: CAR OWNERSHIP NECESSITY		0.039	0.124	0.100	1.000	0.751	-0.204	0.283
FREQUENCY OF CAR USE: Publicly shared car for my own use (Taxi/ Uber/Zipcar/ etc.)	*At least once a month*	0.452	0.230	3.875	1.000	**0.049**	0.002	0.903
	Rarely	0.397	0.220	3.253	1.000	0.071	-0.034	0.829
	Never	0a	.	.	0.000	.	.	.

Link function: Logit.

a This parameter is set to zero because it is redundant.

Model Four: Intention to commute by public car shared with strangers

The base category tested for the set of independent variables in Model Four was the intentional statement *"I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know."* Statistical significance for the Likelihood Ratio Chi-square Test, presented in Table 5.8.16, indicates that the null hypothesis for Model Four can be rejected, and that the intercept model without predictors is not as good as the model with predictors.

Table 5.8.16: Model Four - Likelihood Ratio Chi-square Test

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1226.232			
Final	1085.608	140.624	13	0.000

Again, no statistical significance, with $p > 0.05$, was achieved for Pearson Chi-square Tests and Deviance statistics, presented in Table 5.8.17, meaning the developed model fits the data well.

Table 5.8.17: Model Four – Pearson Chi-square Test and Deviance Statistics

Statistics	Chi-Square	df	Sig.
Pearson	1752.68	1691	0.145
Deviance	1085.608	1691	1.000

The Test of Parallel Lines, presented in Table 5.8.18, was insignificant, with $p > 0.05$, meaning the categories in the model were parallel, and the ordinal logistic regression approach was a good fit to the data.

Table 5.8.18: Model Four – Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1085.608			
General	1047.747	37.862	39	0.522

The model, according to Table 5.8.19, achieved a value for Cox and Snell *pseudo*-R^2 with Nagelkerke correction, equal to 0.297, depicting a fairly high, compared to other models, association of explanatory variables with the studied intention.

Table 5.8.19: Model Four – Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0.281
Nagelkerke	0.297
McFadden	0.115

Table 5.8.20 presents the Parameter Estimates table for the intentional Likert-scale statement "I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know". The studied intentional Likert-scale statement tends to be significantly correlated with five out of nine explanatory variables employed in the ordinal logistic regression model as their significance $p < 0.05$. Similar to Model Three, four of the significant predictor variables for the studied here intention were the EFA generated factors, while the fifth one referred to past behaviour. There are both positive and negative significant correlations among the predictor variables and the studied intention.

The third factor titled "Human Element Externalities" appeared to be a significant (*Wald* $x^2 = 53.820$ and $p < 0.001$) and also the most powerful predictor of the intention "I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know". The estimate (β) for the factor achieved a value of -0.970 (*95% CI -1.229 to -0.711*) thus suggesting a negative association of the factor with the studied intention. Therefore, for every one unit increase on the factor "Human Element Externalities" there was a predicted decrease of 0.970 in the odds of adopting the intention to commute by public cars shared with strangers when equipped with MaaS.

In this model again the first factor titled "Added Value" was also a significant predictor of the studied intention (*Wald* $x^2 = 10.990$ and $p < 0.05$). The estimate (β) for the factor achieved a value of 0.605 (*95% CI 0.247 to 0.963*); therefore, for every one unit increase on the factor "Added Value" there was an associated increase of 0.605 in the odds of adopting the intention to commute by public cars shared with strangers when equipped with MaaS.

The factor titled "Cost Incentives" was also a significant predictor in the developed ordinal logistic regression model (*Wald* $x^2 = 5.890$ and $p < 0.05$). The factor was positively associated with the studied intentions, as the estimate (β) for the factor achieved a value of 0.426 (*95% CI 0.082 to 0.770*). Thus, for every one unit increase on the factor "Cost Incentives" there was a predicted increase of 0.426 in the odds of adopting the intention "I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know".

The sixth factor "Car Use Morality" appeared a significant predictor (*Wald* $x^2 = 5.813$ and $p < 0.05$) of the intention to commute by public cars shared with strangers when equipped with MaaS. Here, the estimate (β) achieved a value of 0.318 (*95% CI 0.060 to 0.577),* meaning there was a predicted increase of 0.318 in the odds of falling at a higher level on the intention to commute by public cars

shared with strangers when equipped with MaaS for every one unit increase on the factor “Lack of Morality”.

The last statistically significant explanatory variable in this model referred to one of the past behaviour items and included travel by personal car on as a passenger on daily basis (*Wald* x^2 = *7.092* and $p < 0.05$). So, as the value of estimate (β) achieved -1.368 (*95% CI -2.375 to -0.361*), there was a predicted decrease of 1.368 in the likelihood of adopting the intention “I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know” for the respondents who travelled by private car as a passenger on a daily basis.

Table 5.8.20: Model Four – Parameter Estimates for Intention to commute by public car shared with strangers

Parameter		Estimate (β)	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
INTENTIONAL BEHAVIOUR: I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know	*Extremely unlikely*	-0.857	0.953	0.808	1.000	0.369	-2.725	1.012
	Unlikely	1.016	0.955	1.132	1.000	0.287	-0.856	2.889
	Neither likely nor unlikely	2.344	0.958	5.982	1.000	0.014	0.466	4.222
	Likely	5.430	1.015	28.644	1.000	0.000	3.441	7.418
FACTOR 1: ADDED VALUE		0.605	0.182	10.990	1.000	**0.001**	0.247	0.963
FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT		-0.030	0.138	0.047	1.000	0.828	-0.300	0.240
FACTOR 3: HUMAN ELEMENT EXTERNALITIES		-0.970	0.132	53.820	1.000	**0.000**	-1.229	-0.711
FACTOR 4: TRUST IN FUNCTIONALITY		0.027	0.140	0.037	1.000	0.847	-0.248	0.302
FACTOR 5: COST INCENTIVES		0.426	0.176	5.890	1.000	**0.015**	0.082	0.770
FACTOR 6: CAR USE MORALITY		0.318	0.132	5.813	1.000	**0.016**	0.060	0.577
FACTOR 7: TRUST IN ENABLING TECHNOLOGY		-0.076	0.096	0.622	1.000	0.430	-0.265	0.113
FACTOR 8: CAR OWNERSHIP NECESSITY		0.131	0.125	1.097	1.000	0.295	-0.114	0.376
FREQUENCY OF CAR USE: Private car as a passenger	*Daily*	-1.368	0.514	7.092	1.000	**0.008**	-2.375	-0.361
	Few times a week	-0.204	0.318	0.412	1.000	0.521	-0.828	0.419
	Once a week	-0.526	0.356	2.182	1.000	0.140	-1.223	0.172
	At least once a month	-0.532	0.323	2.718	1.000	0.099	-1.164	0.100
	Rarely	-0.056	0.291	0.037	1.000	0.847	-0.627	0.515
	Never	0a	.	.	0.000	.	.	.

Link function: Logit.

a This parameter is set to zero because it is redundant.

Model Five: Intention to commute by public transport combined with other modes

The base category tested for the set of independent variables in Model Five was the intentional Likert-scale statement, related to regular commute, stating *"I would use MaaS and commute by public transport combined with other transport options."* The developed for the statement ordinal logistic regression model achieved statistical significance, with $p < 0.05$, for Likelihood Ratio Chi-square Test, presented in Table 5.8.21; therefore, the null hypothesis that the intercept model, or the model without predictors, is as good as the model with predictors, was rejected.

Table 5.8.21: Model Five – Likelihood Ratio Chi-square Test

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1198.208			
Final	1035.739	162.469	13	0.000

As evident from Table 5.8.22, no statistical significance, with $p > 0.05$, was achieved for Pearson Chi-square Tests and Deviance statistics, suggesting good fit of the model to the data.

Table 5.8.22: Model Five - Pearson Chi-square Test and Deviance Statistics

Statistics	Chi-Square	df	Sig.
Pearson	1741.28	1694	0.056
Deviance	1035.739	1694	1.000

The null hypothesis significance testing through the Test of Parallel Lines, presented in Table 5.8.23, also resulted in insignificant results, with $p > 0.05$, this way suggesting the categories in the model were parallel, and the ordinal logistic regression approach was a good fit to the collected data.

Table 5.8.23: Model Five – Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1035.739			
General	989.117	46.622	39	0.188

The model, as evident from Table 5.8.24, achieved a moderately high value of 0.337 for Nagelkerke *pseudo*-R^2 depicting one of the strongest associations among variables compared to other developed ordinal logistic regression models.

Table 5.8.24: Model Five – Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0.316
Nagelkerke	0.337
McFadden	0.136

Table 5.8.25 presents the Parameter Estimates table for the intentional Likert-scale statement "I would use MaaS and commute by public transport combined with other transport options". The intention tends to be significantly correlated with five out of nine explanatory variables used in the analysis, where $p < 0.05$. Four of those significant predictor variables were the EFA generated factors, while the fifth one was a demographic feature used in the survey. Similar to the previous models, the five explanatory variables exhibited both positive and negative regression coefficients.

This was the fifth model where the factor titled "Added Value" was a significant predictor of the studied intention (*Wald* $x^2 = 19.692$ and $p < 0.001$). An increase in the factorial variable "Added Value" was associated with an increase in the odds of being more likely to adopt the intention "I would use MaaS and commute by public transport combined with other transport options", with an odds ratio, or the estimate (β), of 0.811 (*95% CI 0.453 to 1.169*).

The factor titled "Human Element Externalities" was also a significant predictor in the developed ordinal logistic regression model (*Wald* $x^2 = 10.579$ and $p < 0.05$). The factor was negatively associated with the studied intention, as the estimate (β) for the factor achieved a value of -0.419 (*95% CI -0.672 to -0.167*). Thus, for every one unit increase on the factor "Human Element Externalities" there was a predicted decrease of 0.419 in the odds of being more likely to adopt the studied intention.

Another significant factorial explanatory in the model was the factor titled "Cost Incentives" (*Wald* $x^2 = 21.041$ and $p < 0.001$), the estimate (β) for which achieved a value of 0.817 (*95% CI 0.468 to 1.166*). Therefore, for every one unit increase on the factor "Cost Incentives" there was a predicted increase of 0.817 in the odds of being likely to adopt the intention to commute by public transport combined with other transport options when equipped with MaaS.

The factor "Trust in Enabling Technology" appeared a predictor of the studied intention to commute by public transport combined with other transport options when equipped with MaaS that was closely approaching the set for this quantitative inquiry significance value benchmark of 0.05 (*Wald* $x^2 = 3.805$ and $0.05 < p < 0.06$). The estimate (β) value of -0.193 meant that for a one

unit increase on the factor “Trust in Technology” there was a predicted decrease of 0.193 in the odds of falling at a higher level on the intention to commute by public transport combined with other transport options when equipped with MaaS; though, the 95% CI ranging from -0.387 to 0.001, implied a possibility of positive, although extremely low, association of the factor with the dependent variable.

Model Five was the first one where a demographic feature, namely annual household income, was found to be a significant predictor of the studied intention. So, for the survey respondents in the lowest annual household income category of £0 to £15,000 (*Wald* $x^2 = 6.521$ and $p < 0.05$), there was a predicted decrease of 0.926, according to the estimate (β) of -0.926 (*95% CI -1.636 to -0.215*) in the likelihood of adopting the intention “I would use MaaS and commute by public transport combined with other transport options”.

Table 5.8.25: Model Five - Parameter Estimates for Intention to commute by public transport combined with other modes

Parameter		Estimate (β)	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
INTENTIONAL BEHAVIOUR: I would use MaaS and commute by public transport combined with other transport options	*Extremely unlikely*	0.229	0.975	0.055	1.000	0.814	-1.683	2.140
	Unlikely	1.705	0.980	3.029	1.000	0.082	-0.215	3.626
	Neither likely nor unlikely	3.389	0.991	11.684	1.000	0.001	1.446	5.332
	Likely	6.311	1.014	38.776	1.000	0.000	4.325	8.298
FACTOR 1: ADDED VALUE		0.811	0.183	19.692	1.000	**0.000**	0.453	1.169
FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT		0.016	0.141	0.013	1.000	0.908	-0.261	0.294
FACTOR 3: HUMAN ELEMENT EXTERNALITIES		-0.419	0.129	10.579	1.000	**0.001**	-0.672	-0.167
FACTOR 4: TRUST IN FUNCTIONALITY		-0.010	0.144	0.005	1.000	0.943	-0.292	0.272
FACTOR 5: COST INCENTIVES		0.817	0.178	21.041	1.000	**0.000**	0.468	1.166
FACTOR 6: CAR USE MORALITY		-0.107	0.132	0.658	1.000	0.417	-0.366	0.152
FACTOR 7: TRUST IN ENABLING TECHNOLOGY		-0.193	0.099	3.805	1.000	**0.051**	-0.387	0.001
FACTOR 8: CAR OWNERSHIP NECESSITY		-0.018	0.128	0.020	1.000	0.887	-0.268	0.232
INCOME: What is the rough annual income of your household after tax?	*£0-£15,000*	-0.926	0.363	6.521	1.000	**0.011**	-1.636	-0.215
	£15,000-£30,000	0.122	0.343	0.127	1.000	0.721	-0.549	0.794
	£30,000-£50,000	-0.348	0.325	1.144	1.000	0.285	-0.986	0.290
	£50,000-£75,000	-0.299	0.368	0.658	1.000	0.417	-1.020	0.423
	£75,000+	-0.161	0.402	0.161	1.000	0.689	-0.950	0.628
	Prefer not to say	0a	.	.	0.000	.	.	.

Link function: Logit.

a This parameter is set to zero because it is redundant.

Model Six: Intention to travel more

The base category tested for the set of independent variables in Model Six was the intentional Likert-scale statement, related to regular commute, stating *"Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment."* Statistical significance for the Likelihood Ratio Chi-square Test, presented on Table 5.8.26, indicates that the null hypothesis for the developed model can be rejected, and that the intercept model without predictors is not as good as the final model with predictors.

Table 5.8.26: Model Six – Likelihood Ratio Chi-square Test

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1233.561			
Final	1043.945	189.617	14	0.000

As evident from Table 5.8.27, no statistical significance, with $p > 0.05$, was achieved for Pearson Chi-square Tests and Deviance statistics, suggesting good fit of the model to the data.

Table 5.8.27: Model Six – Pearson Chi-square Test and Deviance Statistics

Statistics	Chi-Square	df	Sig.
Pearson	1674.821	1690	0.599
Deviance	1043.945	1690	1.000

The null hypothesis significance testing through the Test of Parallel Lines, presented in Table 5.8.28, also resulted in insignificant results, with $p > 0.05$, this way suggesting the categories in the model were parallel, and the ordinal logistic regression approach was a good fit to the collected data.

Table 5.8.28: Model Six – Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1043.945			
General	991.953	51.991	42	0.139

According to Table 5.8.29, the model achieved a comparatively high value of 0.38 for Nagelkerke *pseudo*-R^2 depicting one of the strongest associations among variables compared to other developed ordinal logistic regression models.

Table 5.8.29: Model Six – Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0.359
Nagelkerke	0.38
McFadden	0.154

Table 5.8.30 presents the ordinal logistic regression model for the studied intentional Likert-scale statement. The intention tends to be significantly correlated with four out of ten explanatory variables used in the analysis, where $p < 0.05$. Two of those significant predictor variables were the EFA generated factors, while one was a past behaviour item and another one was a socio-demographic feature used in the survey. The four explanatory variables exhibited both positive and negative regression coefficients.

The factor titled "Added Value" was a significant predictor also in the study of the above intention (*Wald* $x^2 = 53.104$ and $p < 0.001$). An increase in the factorial variable "Added Value" was associated with an increase in the odds of being more likely to adopt the intention "Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment", with an odds ratio, or the estimate (β), of 0.678 (*95% CI 1.019 to 1.769*). Another significant factorial explanatory in the model was the factor titled "Cost Incentives" (*Wald* $x^2 = 14.639$ and $p < 0.001$), the estimate (β) for which achieved a value of 0.817 (*95% CI 0.331 to 1.025*). Therefore, for every one unit increase on the factor "Cost Incentives" there was a predicted increase of 0.817 in the odds of being likely to adopt the intention to travel more given MaaS offers access to all available transport for a fixed periodic payment.

Another statistically significant explanatory variable referred to past behaviour, namely "Car Ownership" (*Wald* $x^2 = 7.495$ and $p < 0.05$). So, as the estimate (β) for "Car Ownership" achieved a value of 0.638 (*95% CI 0.181 to 1.095*), there was a predicted increase of 0.638 in the odds of falling at a higher level of likelihood on the intention to travel more given MaaS offers access to all available transport for a fixed periodic payment.

Model Six was the last model developed and the second one where a demographic feature, namely annual household income as in Model Five, was found to be a significant predictor of the studied intention. Here though, for the survey respondents in the highest annual household income category of £75,000+ (*Wald* $x^2 = 3.840$ and $p < 0.05$), there was a predicted decrease of 0.788 (*95% CI -1.577 to 0.000*) in the likelihood of adopting the intention "Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment"

Table 5.8.30: Model Six – Parameter Estimates for Intention to travel more

Parameter		Estimate (β)	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
INTENTIONAL BEHAVIOUR: Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment	*Extremely unlikely*	3.703	0.999	13.750	1.000	0.000	1.746	5.660
	Unlikely	5.812	1.017	32.644	1.000	0.000	3.818	7.805
	Neither likely nor unlikely	7.190	1.038	48.002	1.000	0.000	5.156	9.224
	Likely	9.616	1.075	79.937	1.000	0.000	7.508	11.723
FACTOR 1: ADDED VALUE		1.394	0.191	53.104	1.000	**0.000**	1.019	1.769
FACTOR 2: CAR USE CONVENIENCE AND ENJOYMENT		0.078	0.141	0.310	1.000	0.578	-0.198	0.355
FACTOR 3: HUMAN ELEMENT EXTERNALITIES		-0.179	0.127	1.993	1.000	0.158	-0.427	0.069
FACTOR 4: TRUST IN FUNCTIONALITY		-0.235	0.144	2.672	1.000	0.102	-0.518	0.047
FACTOR 5: COST INCENTIVES		0.678	0.177	14.639	1.000	**0.000**	0.331	1.025
FACTOR 6: CAR USE MORALITY		0.120	0.132	0.823	1.000	0.364	-0.139	0.379
FACTOR 7: TRUST IN ENABLING TECHNOLOGY		0.062	0.098	0.399	1.000	0.528	-0.130	0.253
FACTOR 8: CAR OWNERSHIP NECESSITY		0.185	0.128	2.078	1.000	0.149	-0.066	0.436
CAR OWNERSHIP: Do you have a car in your household?	*No*	0.638	0.233	7.495	1.000	**0.006**	0.181	1.095
	Yes	0a	.	.	0.000	.	.	.
INCOME: What is the rough annual income of your household after tax?	*£0-£15,000*	-0.300	0.367	0.668	1.000	0.414	-1.018	0.419
	£15,000-£30,000	0.005	0.343	0.000	1.000	0.989	-0.667	0.676
	£30,000-£50,000	-0.435	0.325	1.792	1.000	0.181	-1.073	0.202
	£50,000-£75,000	-0.379	0.367	1.069	1.000	0.301	-1.098	0.340
	£75,000+	-0.788	0.402	3.840	1.000	**0.050**	-1.577	0.000
	Prefer not to say	0a	.	.	0.000	.	.	.

5.9. Conclusions: Finalising the Framework

Having collected additional data via quantitative survey and analysed the collected data using a mixture of EFA, univariate analysis, and ordinal regression modelling, the author has enhanced the findings of the literature review and the qualitative phase of this study. First, the statistical analysis provided evidence regarding the acceptance of MaaS on either pay-as-you-go or subscription basis, for the UK general public context, and the acceptance likelihood is far higher than the numbers reported in the literature. The analysis also generated evidence regarding possible travel behavioural response to the introduction of MaaS. So, the respondents were found to be very likely to still own a car in the MaaS era, and, also, substitute their public transport trips with car-based shared use mobility services. Moreover, the respondents were found to be very likely to make more trips when equipped with MaaS. Lastly, the respondents were found to be highly and almost equally likely to commute by either car based shared use mobility services on individual basis or combinations of public transport with other transport modes, whist majorly hesitating the use of collective car-based shared use mobility services for commute.

As for the drivers of MaaS acceptance and travel behavioural intentions, the EFA of 40 Likert-scale items, developed based on Thematic Analysis findings, has resulted in not five, but eight core themes, or factors, which were still very much related to what has been discovered through the qualitative inquiry. These factors included Added Value, Car Use Convenience and Enjoyment, Human Element Externalities, Trust in Functionality, Cost Incentives, Car Use Morality, Trust in Enabling Technology, and Car Ownership Necessity. Whilst not producing rigorous ordinal regression models for acceptance intentions, the generated set of factors were found to play a major role in the formation of general travel behavioural, trip generation, and commuting intentions with MaaS. Moreover, the quantitative inquiry has ensured the role of past behaviour in the formation of general travel behavioural and commuting intentions with MaaS, whilst no direct influence of socio-demographic variables, with exception of household income, on the latter intentions was established.

CHAPTER 6. DISCUSSION

6.1. Introduction

This Chapter provides inferences derived from the evidence generated by the qualitative and quantitative data analyses discussed in Chapter 4 Qualitative Phase and Analysis and Chapter 5 Quantitative Phase and Analysis. Fulfilling the research objectives, set in introductory Chapter 1, in a robust way adopting the presented in the Chapter 2 Literature Review theoretical framework, was the rationale behind the selection of sequential mixed methods approach to this study consisting of a qualitative phase followed by quantitative investigation. Thus, this Chapter brings together the two complementary parts of the research and creates a single holistic narrative that will allow the author *to develop the empirical understanding of potential travel behavioural implications of MaaS identifying opportunities and challenges in its ability to create sustainable travel behavioural change, and produce evidence-based recommendations for policy makers and mobility providers to support sustainable travel behaviour with MaaS*, thereby fulfilling this study's overall aim. Whilst referring to the literature identified previously and presented in Chapter 2 Literature Review, this synthesis incorporates relevant findings also from an extensive *post-analysis review of the literature* – the step undertaken in order to follow the theory development strategy for ensuring rigour (Morse et al., 2002), which, as described in Chapter 3 Methodology, requires linking the primary research findings to the literature upon completion of the analysis and not prior. The Discussion Chapter is organised in a way that corresponds to, and specifically addresses, the research objectives of the project as presented in Chapter 1 and below:

(III) To explore the factors underpinning the acceptance and travel behavioural intentions of transport users in response to MaaS identifying challenges and opportunities in creating genuinely sustainable travel behaviour;

(IV) To explore the relationships and dynamics between the factors and MaaS induced acceptance and travel behavioural intentions.

Thus, section 6.2 of the Discussion Chapter provides the overview of potential MaaS acceptance and travel behavioural implications identified at the qualitative and quantitative phases of this research. Section 6.3 of the Chapter discusses the factors identified as the drivers behind MaaS acceptance and travel behavioural intentions, thereby fulfilling objectives (I) and (II) of this study.

The answers pertaining to each of the objectives are marked as (I) and (II) accordingly. The Chapter is then concluded by a summary of the key results of this critical analysis.

6.2. Interpreting Evidence regarding MaaS Acceptance and Travel Behavioural Intentions

As identified via an extensive review of MaaS-related literature, at present the potential acceptance of MaaS service by transport users remains low, and the potential MaaS induced mobility consumption and modal choices of these adopters may not be entirely sustainable. At the qualitative phase of the research presented in this thesis a multitude of acceptance and behavioural responses to MaaS were established all supporting the findings from the literature. So, participants were generally positive about the service willing to see it in action. Some of the interview participants assumed they would no longer need to own a car be MaaS available to them. Others demonstrated how they could turn to more sustainable travel behavioural practices by switching from personal cars to public transport. Many, however, were willing to substitute their cars with the use of car-based shared use mobility services or were not willing to cease car use at all. These acceptance and travel behavioural intentions were then tested at the quantitative phase of the research, with a total of nine acceptance and travel behavioural Likert-scale statements developed for this purpose.

The acceptance was measured by testing two Likert-scale statements concerning the hypothetical use of MaaS in either pay-as-you-go or bundle forms, namely the statement "I would use MaaS on a pay-as-you-go basis" and the statement "With MaaS I would choose the daily/weekly/monthly package payment option". According to the results of statistical analysis, *a total of 79% of respondents were either likely or extremely likely to use MaaS on pay-as-you-go basis, purchase a MaaS bundle, or use both forms of the service. These results indicate a significantly higher interest in MaaS among UK general public than in other countries where MaaS acceptance has been studied*, such as Australia (Ho et al., 2018; 2020; Vij et al., 2020), the Netherlands (Alonso Gonzalez et al., 2020; Caiati et al., 2020; Fioreze et al., 2019; Jang et al., 2020), Switzerland (Hoerler et al., 2020), Finland (Liljamo et al., 2020), or Germany (Keller et al., 2018). Moreover, *these numbers also exceed the ones previously established in the UK context* (Ho et al., 2020; Matyas & Kamargianni, 2018; 2020).

The intentional travel behavioural response to MaaS among UK general public was tested using seven intentional Likert-scale statements. Four out of seven intentions concerned general travel

behaviour with MaaS, whilst the remaining three tested intentional travel behaviour in a more specific context, i.e., regular commute. So, as many as 61% of survey respondents were to some extent unlikely to conform to the statement "With MaaS I would consider not owning a car", while only 19% were likely to behave according to the latter. This means that in most cases ***MaaS is rather unlikely to reduce car ownership levels among transport users***, in a way supporting the findings of Storme et al. (2020) regarding poor car substitution effects of MaaS. Moreover, as many as 57% of survey respondents were likely to behave according to the statement "With MaaS I would replace some of my public transport trips with publicly shared cars", which means that ***MaaS, by granting easy access to services like carsharing, ride-hailing, and ride-sharing, is very likely to induce modal shift away from public transport onto car-based shared use mobility, this way promoting unsustainable travel behaviour among transport users and increasing car agglomeration,*** confirming what has previously been highlighted by Hensher (2017) and Pangbourne et al. (2020). Furthermore, as many as 65% of survey respondents were to some extent likely to behave according to the statement "I would travel to places I couldn't get to before if MaaS offered me transport options to do it", and a total of 58% were likely to conform to the statement "Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment". This means that ***MaaS is very likely to induce additional trips and generate a surplus of vehicle miles travelled, putting more pressure on the already busy transportation networks***, which may be the result of MaaS offering increased accessibility in reaching places (Jittrapirom et al., 2017) or additional value from an all-inclusive MaaS subscription (Pangbourne et al., 2018).

As for commuting intentions, a half of all respondents, or 50% were either likely or extremely likely to behave according to the statement "I would use MaaS and commute by public transport combined with other transport options", with 16% of those, or 69 out of 427 at present commuting unimodally by private car, and 18%, or 78 out of 427 commuting by public transport, either on its own or in combination with other transport options. Almost an equal number of respondents, or 47%, however, were likely to conform to the intention "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use", with 19% of those, or 84 out of 427 commuting unimodally by private car, 9%, or 40 out of 427 being active travellers, and 15%, or 64 out of 427 being regular public transport commuters, either unimodal or adding other transport modes to their journeys. ***This means that although public transport based multimodal offering interests transport users the most when shifting to MaaS based commute, publicly shared cars for individual use face almost an equivalent interest. Moreover, both private***

car drivers and public transport users are almost equally likely to switch to either public transport based multimodal offering or services like carsharing and ride-hailing for their MaaS based commute. Only 24% of surveyed transport users were to some extent likely to conform to the intention "I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know", with public transport commuters (circa 9%, or 39 out of 427) being the most interested in the option, followed by unimodal car drivers (circa 9%, or 37 out of 427), and active travellers (circa 4%, or 19 out of 427). Thus, *collective sharing of cars is not of much interest to the transport users,* an issue brought to discussion also by Marsden et al. (2019). *When selected as an option for commute, collective sharing is also more likely to be used in place of public transport, private car, or even active travel. Such modal shifts may result in decreased private car but increased public car agglomeration while compromising public transport viability and effectiveness in sustainability terms, as well as reduce public activity levels and thereby compromise public health,* an issue previously noted by Pangbourne et al. (2020).

Thus, it can be concluded that MaaS is very likely to induce unsustainable travel behavioural practices among its users if not provided and implemented with societal goals at its core, going in line also with what has been identified and presented in the Chapter 2 Literature Review. Car ownership levels are unlikely to reduce, while car agglomeration may increase due to popularity of easily accessible car-based shared use mobility options in place pf private cars but also public transport and active travel modes, such as cycling and walking.

6.3. Factors affecting the Acceptance and Travel Behavioural Intentions with MaaS

Via an extensive review of MaaS related literature, presented in Chapter 2 Literature review, a conceptual framework of MaaS Acceptance and Intentional Travel behaviour was formed. According to this framework, MaaS acceptance and induced travel behavioural intentions are guided by individual demographics, general attitudes, and past travel behavioural practices. Applying the developed conceptual framework, the attitudes driving MaaS acceptance and intentional travel behaviour were identified via a qualitative study. These, alongside demographic attributes, and past behaviour items, were then tested quantitatively. This mixed methods analysis resulted in ten factors proven to be the drivers behind MaaS acceptance and travel behavioural intentions, namely the attitudinal factors Car Use Convenience and Enjoyment, Car Ownership Necessity, Car use Morality, Trust in Functionality, Trust in Enabling Technology, Human Element Externalities, Added Value, and Cost Incentives, alongside Past Travel Behaviour and Household

Income. These factors and the ways in which they influence MaaS acceptance and travel behavioural intentions are explained further in this section with the aim to fulfil the overall research objectives.

6.3.1. Car Dependence

While the idea of MaaS received generally positive commentary, with participants willing to see the system in action, many still looked at MaaS through the lens of Car Dependence. This MaaS-affecting theme was developed at the qualitative phase with three dimensions, namely *convenience* of both car use and car ownership, the associated *enjoyment*, and *morality*. EFA, though, resulted in this theme dividing into three independent latent factors influencing MaaS acceptance and use, and having a slightly different focus to what was defined qualitatively. So, ***car use convenience and enjoyment*** factor concerned the convenience and enjoyment aspects related solely to car use, covered by six qualitatively infused Likert-scale statements, while ***car ownership necessity*** factor concerned the convenience and enjoyment of owning a car, with three Likert-scale statements falling under. The *morality* dimension of the theme, though, remained unchanged, and had three, developed specifically for it, Likert-scale statements adding to the score of the factor ***car use morality***.

6.3.1.1. Car Use Convenience and Enjoyment

(I) Much like Fioreze et al. (2019) and Ho et al. (2018) suggested, this study revealed that potential users remain dependant on cars due to perceiving MaaS as unable to beat ***car use convenience***. The car was perceived as a more convenient than MaaS option first due to it offering transport users the ability to be independent of public transport having no timetable or destination constraints, and the privacy one cannot get on other means of transport, similar to the car flexibility perceptions (Beirão & Sarsfield Cabral, 2007) and personal space concerns (Gardner & Abraham, 2007), previously identified as the drivers behind car use. Moreover, the car remained a preferred transport mode by both qualitative and quantitative phases participants due to its carrying capacity, protection against bad weather, and safety reasons, which also goes in line with previous work on car use drivers (Burlando et al., 2019). The cost-effectiveness of car use and journey time predictability, although highlighted by both the qualitative phase participants and the related literature (Gardner & Abraham, 2007), at the quantitative phase via EFA proved to have no real

influence in the MaaS domain. It has been long recognised, however, that car is more than just a convenient mode of transport (Beirão & Sarsfield Cabral, 2007; Steg, 2005) and, compared to public transport, scores better on affective aspects such as excitement and control (Anable & Gatersleben, 2005).

The findings of this mixed methods study suggest that the car, to this day, is viewed as the transport mode using which brings ***enjoyment***. As qualitative phase participants suggested, using a car stimulates self-esteem, serves as a means of representing self, and provides a sense of freedom, independence, and joy on top of removing the complexities and uncertainties of relying on other transport modes and on a digitally-enabled system to travel. These are the sensations that not just public transport but even MaaS multimodal offering cannot replicate.

(II) While the convenience of car use has been brought up in the MaaS agenda as a barrier to its acceptance (e.g., Ho et al., 2018) and use (e.g., Storme et al., 2020), to the best of author's knowledge, the effect of car use convenience, and moreover, enjoyment, on travel behavioural response to MaaS this far has not been investigated. Thus, defined by a total of six Likert-scale statements, namely "I travel by car because I can carry luggage/shopping/all the things I need without hassle" (*IV_03, $\mu = 4.21$, $\sigma = 0.915$*), "I travel by car to avoid harsh weather" (*IV_04*, *$\mu = 3.88$, $\sigma = 1.012$*), "I travel by car because I feel safe this way" (*IV_05, $\mu = 3.47$, $\sigma = 1.095$*), "I travel by car to have the privacy I don't get on other means of transport" (*IV_06, $\mu = 3.61$, $\sigma = 1.182$*), "I travel by car to be independent of public transport schedule" (*IV_07, $\mu = 3.86$, $\sigma = 1.122$*), and "I travel by car because I enjoy driving/being in a car" (*IV_12, $\mu = 3.48$, $\sigma = 1.251$)*, the factor ***car use convenience and enjoyment*** generally concerned positive aspects of travelling by car, both private and public, and both as a driver and as a passenger.

Via ordinal regression modelling the discussed herein factor was found to be positively, and significantly, associated with two out of six studied travel behavioural intentions, namely the general travel behavioural intention "With MaaS I would replace some of my public transport trips with publicly shared cars" (*Model Two, $\beta = 0.450$, $p < 0.05$)*, and the commuting intention "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use" (*Model Three, $\beta = 0.265$, $0.05 < p < 0.06$)*. This means that ***transport users holding positive evaluations of general car use, with respect to privacy,***

independence from public transport, weather, carrying capacity, safety, but also enjoyment, are more likely to replace public transport trips with publicly shared cars when shifting to MaaS-based travel, and are also more likely to commute by publicly shared cars, or services like carsharing and ride-hailing, unimodally and for individual use, accessing those via MaaS platforms.

In part supporting the above, Loa & Nurul Habib (2021) argue that individuals who place greater importance on qualitative trip characteristics, such as availability of public transport, safety, and weather, are more likely to adopt ride-hailing services for both individual and collective use. As for enjoyment of driving or being in a car, the evidence is contradicting the findings of this study: Kim & Ullah Jan (2021), for example, found affective engagement with cars to have no considerable effect on the carsharing services use intention. The author argues, however, that the choice of publicly shared cars not over personal car but over public transport and multimodal travel, the use of which is rarely motivated by the feelings of enjoyment and enthusiasm (Steg, 2003), in the case of MaaS appears to be partially the result of hedonic motives associated with car use.

6.3.1.2. Car Ownership Necessity

(I) Attitudes to car ownership had previously been recognised as factors influencing individual decision to participate in transport schemes aimed at reducing car ownership, such as carsharing (Burlando et al., 2019). The developed in this study factor ***car ownership necessity*** confirms the importance of car ownership attitudes also in the context of MaaS based travel. Similar to the discovery of Ikezoe et al. (2020) for the context of carsharing, this work suggests that owning a car would still be a necessity, as stated by qualitative phase participants, for cases of emergency even in the MaaS era; these include urgent hospital visits or unexpected disruption on other transport means, where no room for a lag exists. Study participants considered owning a car necessary also when planning or having a family, which could be explained by the consequent need of transporting children or elderly who have limited ability to travel (Zhao & Bai, 2019), or simply undertaking family activities with less stress (Oakil et al., 2014). As highlighted in the work of Storme et al. (2020), these are the needs that result in poor private car substitution effect of MaaS, due to inability of the service to cover those effectively.

Last but not least, it is the sense of excitement and pleasure associated with "having your own thing" - a private car that not only serves practical needs but is used as a symbol of status and "making it" in life (Shimabukuro Sandes et al., 2019) – that has a role to play in the MaaS uptake. Such sensations are known to have an influence on individual decision to own a car (Johansson-Stenman & Martinsson, 2006). Moreover, this symbolic attachment to a personal car is known to affect public transport use (Beirão & Cabral, 2007), the use of carsharing (Liao et al., 2020; Shimabukuro Sandes et al., 2019), and ride-sharing (Riber Nielsen et al., 2015), and were also found to affect car ownership reduction goals of MaaS (Gairal Casadó et al., 2020; Matyas, 2020).

(II) Defined by the three Likert-scale statements "It's necessary to own a car if you have a family" (*IV_08*, *μ = 3.62, σ = 1.129*), "Owning a car is good because it's having your own thing" (*IV_09*, *μ = 3.26, σ = 1.190*), and "Having your own car is necessary for cases of emergency/disruption" (*IV_10*, *μ = 4.02, σ = 1.017*), the factor ***car ownership necessity*** generally concerned positive evaluations of owning a car. Via ordinal regression modelling the discussed herein factor was found to be negatively, and significantly correlated with general travel behavioural intention "With MaaS I would consider not owning a car" (*Model One, β = -0.686*, *p < 0.05)*. This means that ***transport users who are more likely to consider owning a car a necessity are, as a result, less likely not to own a car even if equipped with MaaS for travel.*** Thus, as previously stated by Mulley et al. (2017), the attitudes to car ownership among transport users must change first; only this way new consumer preferences regarding travel mode, and new, non-private-car-dependent, travel behaviours will emerge when shifting to MaaS transport paradigm.

6.3.1.3. Car Use Morality

(I) Sustainability attitudes have been found to have an influence on driving habits and modal choice (Bamberg & Schmidt, 2003; Gardner, 2009) and the decision to use multimodal travel applications (Dastjerdi et al., 2019a; 2019b). A similar factor, but with an influence on MaaS acceptance and use, was developed in this study and titled ***car use morality***. According to the qualitative findings of this study, transport users with limited moral considerations or, in other words, with the mindset that their unsustainable driving habits are "a drop in the ocean" appear unlikely to abandon car use, and travel with MaaS sustainably, if at all. Increasing transport user awareness of the negative consequences of travelling by car,

though, offers the potential to reduce car use among transport users (Abrahamse et al., 2009). Supporting the above argument but also what was previously discovered by Fioreze et al. (2019) and Hoerler et al. (2020) for the MaaS context, the findings of this study suggest that transport users who realise the impact of car use on the environment and voice concerns about the latter already look for ways to reduce their dependence on cars and see MaaS as a means for identifying more sustainable travel options, at least for some of their trips, and as a way of contributing to maintaining sustainability.

(II) With the three qualitatively infused Likert-scale statements, namely "The environment does not concern me" (*IV_13, $\mu = 1.82$, $\sigma = 0.967$)*, "I think me using a car has little to do with climate change" (*IV_14, $\mu = 2.21$, $\sigma = 1.082$)*, and "I think congestion is not an issue for the environment" (*IV_15, $\mu = 1.66$, $\sigma = 0.831$)*, adding to its score, the factor ***car use morality*** generally discussed lack of concern with environmental sustainability related to car use.

Via ordinal regression modelling, the discussed herein factor was found to be significantly, and positively, correlated with two travel behavioural intentions, namely the commuting intention "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use" (*Model Three, $\beta = 0.450$, $p < 0.05$)* and the commuting intention "I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know" (*Model Four, $\beta = 0.318$, $p < 0.05$).* This means that ***transport users who are more likely to believe car use has little to no impact on environmental sustainability are more likely to commute by publicly shared cars, or carsharing, ride-hailing, and ride-sharing services, unimodally, accessing those via MaaS platforms.***

The above in a way contradicts the findings of, for example, Burkhardt & Millard-Ball (2006), who found the use of carsharing to be driven by strong concerns about the environment, or Hjorteset & Böcker (2020), according to whom individuals concerned with the environment have stronger intentions to use carsharing as they associate it with a more environmentally friendly future transport system. It is known, however, that compared to other transport modes, public transport and multimodal travel score the highest in sustainability and environmental terms, while, for an instance, carsharing services are rated as the least sustainable, though after private car (Anable & Gatersleben, 2005; Clauss & Döppe, 2016). This means that in the context of MaaS, the choice of unimodal travel by publicly shared car is a result lower sustainability, or more specifically environmental, awareness than required

for the choice of, for example, public transport based multimodal offer. This is especially concerning as not only private car drivers but also regular public transport users, according to univariate analysis results, show the strongest preference towards car-based shared use options for commute.

6.3.2. Trust

The affection for privately owned cars and personal driving was not, however, the only reason study participants did not show much enthusiasm about extensively relying on MaaS. The qualitatively developed theme Trust, with its *trialling*, *capacity*, *efficiency*, *technology*, *digital readiness*, and *cyber-security* dimensions, provides a detailed account of trust issues underpinning incidents of MaaS disapproval. According to Roger's (2003) DoI Theory, an individual often expresses the need to trial an innovation before its full adoption in order to give meaning to an innovation, to eliminate uncertainty and to find out how it functions in real terms. Similarly, qualitative phase participants demonstrated the desire of trialling MaaS. The need to trial the tool appeared also due to qualitative participants doubting the potential MaaS capacity: when today at peak hours, the demand for public transport and shared use mobility can severely outweigh the system's capacity, what would happen on the much larger scale of a MaaS paradigm, when most users abandon their cars? The latter is closely related to the notion of crowding (Li & Hensher, 2013), associated with a high density of passengers on vehicles, access ways and stations, which has a significant influence on modal choice (Tirachini et al., 2013; Vedel et al., 2017; Wardman & Whelan, 2011). The trialling and capacity dimensions, however, were eliminated at the quantitative phase via EFA. The remaining sub-themes, also via EFA, divided into two latent factors named ***trust in functionality***, concerning the informational *efficiency*, *cyber-security*, and *digital readiness* dimensions of qualitatively developed theme, and ***trust in enabling technology***, discussing the equivalent qualitatively-developed *technology* dimension.

6.3.2.1. Trust in Functionality

(I) The *efficiency* of MaaS in terms of providing timely and reliable information, reasonable itineraries, and alternative routes in cases of disruption, was one of the concerns raised by qualitative phase participants. This contradicts the findings of Sochor et al. (2015), for example: according to their study, potential MaaS customers had a high level of trust in the MaaS provider taking care of any problems that could arise. The *digital readiness* concerns,

expressed by qualitative phase participants, suggest that the mobile app form of MaaS could be a major barrier to its uptake as not every potential MaaS user at present is at the desired level of digital readiness (Polydoropoulou et al., 2020a), and, as noted by Pangbourne et al. (2020), older people specifically may be left out.

Other functionality concerns, hindering the uptake of MaaS, included the sharing of personal information, such as credit card information, as in Polydoropoulou et al. (2020a), and location, as in Gairal Casadó et al. (2020). The protection of personal information, and ensuring safety around monetary transactions within MaaS, though, have been considered in recent research (Cottrill, 2020). However, little attention has been paid to the possible *cyber-security* vulnerabilities of MaaS and their mitigation, although cyber-security and resilience planning have been signposted as areas of priority for years now for the broader context of public transport (Beecroft & Pangbourne, 2015a), and are a vital service expectation of potential MaaS users (Sochor et al., 2015; Keller et al., 2018). The frequency of fraud and cyberattacks, often severe, in contemporary times caused qualitative phase participants to fear relying on not just MaaS but any digital system. In the MaaS era cyber-attacks may impose a great amount of risk as they could spread over, and endanger, an entire MaaS coverage area in a short time.

(II) Defined by a total of five Likert-scale statements, namely "I would struggle to use a mobile device and an app to access different transport modes" *(IV_16, $\mu = 2.1$, $\sigma = 1.067$),* "I would worry whether I am being charged correctly for my trips" *(IV_19, $\mu = 3.22$, $\sigma = 1.106$),* "I would not want to share my personal data with MaaS" *(IV_20, $\mu = 3.13$, $\sigma = 1.115$),* "Cyber-security behind MaaS system would concern me" *(IV_21, $\mu = 3.23$, $\sigma = 1.063$),* and "I would not trust the travel information coming through the MaaS app" *(IV_22, $\mu = 2.56$, $\sigma = 0.874$),* the factor ***trust in functionality*** generally discussed the concerns related to the efficiency, digital readiness, and cyber-security of MaaS system.

Via ordinal regression modelling, this factor was found to be significantly, and positively, correlated with the general travel behavioural intention "With MaaS I would consider not owning a car" (*Model One, $\beta = 0.660$, $p < 0.05$)*. However, as previously stated in Chapter 4 Quantitative Phase and Analysis, this factor was expected to have a negative influence on the studied travel behavioural intention, therefore this result is somewhat counterintuitive. Manfreda et al. (2021), studying the impact of security perceptions on adoption of

autonomous vehicles, had a similar outcome: positive evaluations of security behind autonomous vehicles were found to be negatively, though not significantly, correlated with the adoption intention, which was argued to emerge due to security not being questioned at the level of autonomous vehicle adoption, but at the level of vehicle technology generally. For the context of car ownership in the MaaS era and based also on the qualitative findings of this study, the author develops a similar argument: ***when agreeing not to own a car transport users have no other choice but to rely on applications and share information, despite being concerned with the latter, to go about their daily business.***

Notably, this factor was not a significant predictor for any other studied travel behavioural intentions with MaaS, which supports the above argument for not just car ownership but any travel behavioural outcome of shifting to MaaS-based transport paradigm, and, also, goes partly in line with Caiati et al. (2020) and Schikofsky et al. (2020) who argue that privacy and cyber-security issues have no real influence on MaaS adoption intentions. It has to be mentioned, however, that such outcome may also be the result of collecting data, with the exception of a few participants, via a web-based questionnaire that in essence targets digitally literate individuals who have access, and use on regular basis, smartphones and computers and are, quite likely, familiar with the operation of digital applications and the associated risks.

6.3.2.2. Trust in Enabling Technology

(I) When travelling with MaaS, users would have to rely on and ***trust in enabling technology***, which, as stated by qualitative phase participants, generates concerns of whether their smart device would be accepted as a means of access to the many transport modes MaaS promises to integrate, an issue previously highlighted by Giesecke et al. (2016) and Mulley et al. (2018), or, more importantly, whether the battery of their mobile device is sufficiently charged and whether they would have appropriate mobile network coverage where they are travelling. The importance of latter two technological concerns in the MaaS acceptance and use was previously highlighted by Gairal Casadó et al. (2020).

(II) Defined by the qualitatively infused Likert-scale statements "I would worry about the quality of internet coverage where I am going" *(IV_18, $\mu = 3.42$, $\sigma = 1.138$)* and "I would worry whether my mobile device has got enough battery" *(IV_17, $\mu = 3.13$, $\sigma = 1.201$),* the factor

trust in enabling technology reflects transport users' concerns with the reliance on technology when travelling with MaaS.

Via ordinal regression modelling, the discussed herein factor was found to be significantly, and negatively, correlated with two travel behavioural intentions, namely the intention "With MaaS I would consider not owning a car" (*Model One, β = - 0.199*, *p < 0.05),* and the commuting intention "I would use MaaS and commute by public transport combined with other transport options" *(Model Five, β = - 0.193*, *p < 0.05).* This means that ***transport users who are more likely to be concerned with the MaaS enabling technology are, as a result, less likely not to own a car in the MaaS era and are also less likely to choose public transport based multimodal itineraries for their commute when equipped with MaaS.*** Indeed, by losing access to MaaS enabling technology transport users not only loose the means of access to transportation but also access to information necessary to perform public transport based multimodal trips without concern (Beirão & Sarsfield Cabral, 2007), an issue expressed by the participants of this study's qualitative phase, too. Therefore, any MaaS system should also have the means for functioning offline and offer back-up access options other than mobile devices if it is to be embraced, as suggested by Polydoropoulou et al. (2020a).

6.3.3. Human Element Externalities

Reliability, safety on board, and privacy, associated with vehicle occupancy, are the known attributes influencing user perceptions of and satisfaction with transport service quality (Beirão & Sarsfield Cabral, 2007; Garvill et al., 2003; Prioni & Hensher, 2000; Spears et al., 2013) and affecting travel behaviour and modal choice (De Vos & Witlox, 2013). Via this study's qualitative inquiry, similar traits developed also for the context of MaaS, and included *negligence*, *discourtesy and abuse*, and *danger anticipation*. As these traits appeared to be largely of human nature, they were grouped into a single theme defined as the Human Element Externalities. Based on the results of qualitative phase, a total of four Likert-scale statements were developed to represent this theme at the quantitative phase and were all found to drive MaaS acceptance and use via the identified through EFA latent factor ***human element externalities***.

(I) Social environments, perceived by some participants of the qualitative phase as psychologically and physically hazardous, negatively affected the potential uptake of MaaS. Qualitative phase participants reflected on their previous transport experiences and,

realising the service in MaaS was still dependant on the responsibility of its providers, were troubled by the possibility of transport provider staff deceiving them, getting them to their destination with little consideration for their health and safety, and simply not providing the service at the required time, thus demonstrating *negligence* in relation to users. Analogous to the above, personnel and driver behaviour were previously recognised as important attributes of customer satisfaction with public transport service (Mouwen, 2015) and as the drivers of ride-sharing use (Riber Nielsen et al., 2015), however, to the best of author's knowledge, have not yet appeared in the MaaS agenda.

The *discourtesy* of fellow travellers was yet another worry: inappropriateness of some conversations, profanity of the language, and the inability of other transport users to keep noise to a minimum was what made the experiences of sharing transport even with MaaS a non-ideal scenario for some of qualitative phase participants. This is possibly why individuals tend to experience stress when having other transport users in close proximity to them when travelling by public transport (Evans & Wener, 2007; Haywood et al., 2017), for example, or why they perceive ride-sharing as intruding upon solitude (Riber Nielsen et al., 2015).

Another barrier identified was the possible *abuse* of safety rules and dedicated transportation infrastructure by some transport users, but also experiencing abuse on shared means of transport. Going in line with general travel behaviour research, where the provision of personal space and security are argued to pose real challenges to car reduction schemes (Gardner & Abraham, 2007), and to tacitly influence passenger choice (Beecroft & Pangbourne, 2015b), the above also confirms the MaaS-specific findings of Gairal Casadó et al. (2020) and Lopez-Carreiro et al. (2020), who found previous encounters with discourtesy and abuse on public transport means to play a major role in the acceptance and use of MaaS both by younger and older generations.

The above lead the qualitative study participants to *danger anticipation* and expecting harm when sharing the transport with strangers, and, ultimately, generated negative perceptions of travelling with MaaS. This attribute is similar to risk perception, which was found to be related to public transport use intentions (Nordfjærn et al., 2015), and in a way explains why some MaaS-related studies (Lopez-Carreiro et al., 2020) report the need for urban security information being provided via MaaS platforms. The *discourtesy and abuse* and *danger anticipation* traits of Human Element Externalities theme, perhaps, also offer a more detailed

account of the attitude towards sharing the means of transport with strangers, which is deemed important for MaaS acceptance (Fioreze et al., 2019; Alonso-Gonzalez et al., 2020).

(II) Defined by four qualitatively-infused Likert-scale statements "I wouldn't like to share the means of transport with people I don't know" *(IV_25, $\mu = 3.15$, $\sigma = 1.206$)*, "I would stress about the inconsiderate behaviour of fellow travellers" *(IV_26, $\mu = 3.38$, $\sigma = 1.076$)*, "I wouldn't like to be in a crowded environment" *(IV_27, $\mu = 3.61$, $\sigma = 1.091$)*, and "Having to rely on other people for my transport would concern me" *(IV_28, $\mu = 3.79$, $\sigma = 1.021$)*, the factor ***human element externalities*** covered the negative aspects of sharing the means of transport with other travellers and relying on others for the service.

Via ordinal regression modelling, the discussed herein factor was found to be significantly, and negatively, correlated with four out of six studied MaaS travel behavioural intentions, namely the two general travel behavioural intentions "With MaaS I would consider not owning a car" (*Model One, β = = -0.318*, *$p < 0.05$)* and "With MaaS I would replace some of my public transport trips with publicly shared cars" (*Model Two, β = -0.581*, *$p < 0.05$)*, and the commuting intentions "I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know" (*Model Four, β = -0.970*, *$p < 0.05$)* and "I would use MaaS and commute by public transport combined with other transport options" (*Model Five, β = -0.419*, *$p < 0.05$)*. The above means that ***transport users holding negative attitudes towards relying on others for the transport service or towards using shared means of transport are less likely not to own a car when shifting to MaaS paradigm.*** This is expected as personal safety (e.g., crime avoidance) and provision of personal space were some of the drivers of car ownership and use proposed by the participants already at the qualitative stage.

Moreover, ***the higher transport users score on the factor human element externalities the less likely they are to replace public transport trips with publicly shared cars in the MaaS era. They are also less likely to commute by ride-sharing services, where they might either be driven or ride with strangers, or travel by public transport combined with other transport modes for their commute when equipped with MaaS.*** This in a way supports previous research on ride-sharing, where sharing a ride with anyone but someone internal to the household was determined to have a negative impact on ride-sharing intentions (Correia & Viegas, 2011).

Interestingly, the effect of the discussed herein factor on pure ride-sharing intentions (*Model Four, β = -0.970)* is stronger than that on public transport based multimodal travel intentions (*Model Five, β = -0.419*) or travel intentions where publicly shared cars for individual use are also implied (*Model Two, β = -0.581)*. This is not surprising as ride-sharing companies have little control over the drivers, vehicles, or the rides and, thus, are unable to take strict measures against harassment, assault, and robbing events, frequently experienced by ride-sharing users (Chaudhry et al., 2018). Furthermore, as discovered by Evans & Wener (2007) it is not the number of passengers in a vehicle per se, but the immediate proximity of strangers, as in the case of sharing a seat, that causes transport users to experience stress during travel; while it is possible to avoid the latter on public transport means and, for example, when carsharing on individual basis, shared rides do not offer such capacity.

6.3.4. Added Value

While Fioreze et al. (2019) uncovered that the potential acceptance of MaaS was dependent on the transport users' perceptions of service's added value, the qualitative inquiry, via theme Added Value, provided an insight on what users consider value-adding features that influence their decision regarding MaaS acceptance and use, which included *appification and integration, breaking habits, analytics, ad-hoc travel, accounts and feedback,* and *level of service provision*. Based on the results of qualitative phase, a total of seven Likert-scale statements were developed to represent the discussed herein theme at the quantitative stage. Only six of those, however, and one extra statement initially developed to cover a different qualitative theme, were found to drive MaaS acceptance and use via the identified through EFA latent factor ***added value***.

Although the level of digital literacy of some potential users, as also recognised by Polydoropoulou et al. (2020a) and Pangbourne et al. (2020), could complicate the realisation of MaaS as a web- or app-based product, the *appification* was still regarded as a valuable feature by qualitative participants as it was something the majority of them already had experience with and found easy to use. This goes along with the findings of Sochor et al. (2015) and Karlsson et al. (2020) confirming the importance of ease of use for the MaaS acceptance, and with the findings of Ye et al. (2020) regarding the importance of effort expectancy when deciding to adopt MaaS applications. The travel choice making qualities and *integration* capacity of MaaS were also highlighted by some of qualitative study participants, which is in line with the results of Polydoropoulou et al. (2020a). With MaaS, individuals will not have to deal with a variety of apps and webpages but do everything

from a single app. These dimensions of the theme were, however, closely related to the *digital readiness* dimension of the theme Trust, and, therefore, a single statement "I would struggle to use a mobile device and an app to access different transport modes" was developed to cover both dimensions at quantitative stage; via EFA, the statement fell under the factor concerning ***trust in functionality***. MaaS was found to be a valuable tool for organising ad-hoc travel, such as short- and long-distance trips with the purpose of leisure and tourism, in a way confirming the hypothesis of Ho et al. (2018) that tourists may represent the largest market group for MaaS and be its first adopters. This dimension of added value was not, however, tested quantitatively.

(I) Confirming the findings of Strömberg et al. (2018), this work suggests that the all-in-one MaaS service could help *breaking existing travel habits*. The latter could be achieved, as suggested by this study's participants, through MaaS app-based campaigns offering the user more sustainable travel modes or providing carbon footprint and congestion contribution information of each itinerary on offer. The use of such strategies could contribute to sustainable uptake of MaaS and encourage transport users to see MaaS as a symbol of ecological travel – something that not every transport user perceives MaaS to be (Schikofsky et al., 2020).

A MaaS feature for *creating accounts and giving feedback* about drivers delivering the service and fellow travellers, according to qualitative phase participants, could make sharing, at least car-based, as also noted by Casprini et al. (2019), more transparent and easier to get used to; the sensation of knowing that everyone is a part of a wider social network of travellers and, thus, can be easily identified in case a situation occurs might make sharing public and shared means of transport more pleasant and trustworthy. Interestingly, in the study by Polydoropoulou et al. (2020a) potential MaaS users were not willing to use such feature of the MaaS service. In line with Caiati et al. (2020), the findings of this work also suggest that online reviews of the overall MaaS service from those who already used it would also influence individual decision to accept and use the system. The latter refers to the concept of user-generated content that, in the marketing domain, has been previously found to influence individual purchasing intent (Flanagin & Metzger, 2013).

Qualitative phase participants also recognised that MaaS, having access to individual trip and user data, could use *analytics* to help eliminating transport capacity bottlenecks. The latter also supports the findings of Milne & Watling (2019). Yet, the transportation network itself, as it is as present, is far from being able to seamlessly serve user needs and offers no

resilience when dealing with disruption. Significant improvements in the *level of service provision*, however, are of paramount value to users as these tend to induce a positive change in travel behaviour (Redman et al., 2013).

(II) Defined by seven qualitatively-infused Likert-scale statements "I would use MaaS if I was informed about my contribution to reducing carbon footprint" (*IV_29, μ = 3.44, σ = 0.970*), "I would use MaaS if I knew I was contributing to the reduction of overall congestion levels" (*IV_30, μ = 3.65, σ = 0.949*), "I would use MaaS if it offered me a more frequent and flexible public transport service day and night" (*IV_31, μ = 3.99, σ = 0.833*), "I would use MaaS if I was informed about the availability of seats on different transport modes" (*IV_32, μ = 3.89, σ = 0.846*), "If I could see, through MaaS platform, rating and feedback for drivers and fellow travellers, I would use MaaS" (*IV_33, μ = 3.76, σ = 0.913*), "My decision to use MaaS would depend on the people who already used it" (*IV_34*, *μ = 3.5, σ = 1.060*), and initially developed to measure the ***cost*** dimension statement "I would use MaaS if I was offered bonus points and discounts for trips through MaaS app" (*IV_40, μ = 3.66, σ = 0.952*), the factor ***added value*** covered the positive, incentivising aspects of using a MaaS platform for travel.

Via ordinal regression modelling, the discussed herein factor was found to be significantly, and positively, correlated with all six studied travel behavioural intentions. Therefore, ***the more transport users appreciate the incentivising features of MaaS, the more likely they are not to own a car when shifting to MaaS paradigm*** (*Model One, β = 0.709*, *p < 0.05).* Moreover, ***the higher transport users score on the factor added value the more likely they are to use MaaS for their commute and travel by public transport combined with other transport options*** (*Model Five, β = 0.811*, *p < 0.05).* However, ***the appreciation of value-adding MaaS features also increases the likelihood of transport users replacing public transport trips by publicly shared cars*** (*Model Two, β = 0.860*, *p < 0.05),* ***and commuting by publicly shared cars unimodally, both for collective*** (*Model Four, β = 0.605*, *p < 0.05)* ***and individual use*** (*Model Three, β = 0.642*, *p < 0.05).* The latter supports the discovery of Matyas & Kamargianni (2018), according to which potential MaaS users are more willing to choose MaaS packages that include shared use modes of transport when enough value adding features, such as bundling and discounts, are provided.

Interestingly, recognising the added value of travel with MaaS has the strongest, among the presented models, effect on the intention to travel more (*Model Six, β = 1.394*, *p < 0.05).* This means that ***incentivising transport users to travel with MaaS may induce additional trips,***

thereby increasing demand for public transport and shared use mobility even more; this may actually result in non-car-owning individuals switching away from these modes and eventually buying a car (Hörcher & Graham, 2020).

6.3.5. Cost

Qualitative phase participants' considerations about MaaS' ***cost*** made it clear that travel by alternatives is still considered inferior to car use. This MaaS-affecting theme was developed at the qualitative phase with three dimensions, namely *benchmarking against status quo*, *Why to pay? Can do myself*, and *Incentives Reliefs Motives*. Although valuing some of the features MaaS may potentially offer, only a few, as also recognised by Ho et al. (2018), wished to pay extra for the MaaS service. First, this was due to the demonstrated by participants *Why to pay? Can do myself*' attitude with a stance where they would rather plan the trips themselves than pay MaaS for creating an integrated offer, as there were already free of charge apps and services in place that they could easily use instead. The related to the above Likert-scale statement "I would pay more for MaaS than what I currently spend on my transport" was, though, eliminated via EFA at the quantitative phase.

(I) Generally, qualitative phase participants were ready to pay the same amount for MaaS as what they spent on transport before the service, but had a clear preference to pay less, if possible, which goes in line with the findings of a number of MaaS related studies on individual willingness-to-pay (Ho et al., 2018; 2020; Liljamo et al., 2020; Mulley et al., 2020). Provided the cost of travel with MaaS was lower than what they paid previously some qualitative phase participants were ready to accept a slight increase in travel time, which goes in line with the findings of Fioreze et al. (2019). These referrals to and comparisons with the transport spending before MaaS were grouped into a dimension of the discussed herein qualitative theme titled *benchmarking against status quo*.

Other qualitative phase participants mentioned how they wished to be *incentivised* to use MaaS by getting, through the MaaS platform, bonus points or discounts for every trip, for example. The latter reward instruments could be successful in promoting sustainable multimodal options (Dastjerdi et al., 2019b; Tsirimpa et al., 2019), thereby facilitating a positive change in individual travel behaviour (Poslad et al., 2015), and in a recent MaaS trial, in combination with monthly fee, was found to gain acceptance for MaaS bundles and impact

private car use (Hensher et al., 2021), whilst also influencing the choice of modes within the bundle (Feneri et al., 2010). The related statement "I would use MaaS if I was offered bonus points and discounts for trips through MaaS app", however, as mentioned previously, at the quantitative phase, via EFA, fell under the MaaS-defining factor ***added value***.

Some participating car users at the qualitative phase mentioned, rather reluctantly, that the only way out of driving for them would be the policy makers putting in place *motives* such as environmental laws and excessive charges for personal car use and ownership. Indeed, road pricing schemes, although often challenged by public resistance, grant more significant reduction in emissions as opposed to, for example, shared use mobility schemes (Cavallaro et al., 2018), which could be a consequence of reduced car use. Car-using qualitative phase participants, as also suggested by Stradling et al. (2000), were more open to "pull" measures such as being offered tax *reliefs* for switching from their car to more sustainable alternatives. Such policy, also referred to as tax break or tax exemption, has already been successfully utilised to promote the use of electric and more fuel-efficient cars (Bjerkan et al., 2016; Orlov & Kallbekken, 2019) and appears to also have potential to reduce overall car use (Gardner & Abraham, 2007) and the associated emissions (de Haan et al., 2009).

(II) Defined by four qualitatively-infused attitudinal Likert-scale statements "I would use MaaS if travelling with it worked out cheaper than what I currently spend on my transport" (*IV_35, $\mu = 3.9$, $\sigma = 0.897$*), "I would use MaaS if travelling with it would cost me about the same as what I currently spend on my transport" (*IV_37, $\mu = 3.15$, $\sigma = 1.019$*), "If government increased the cost of car ownership and private car use, I would use MaaS" (*IV_38, $\mu = 3.33$, $\sigma = 0.980$*), and "If government offered financial reliefs for switching from private car to MaaS, I would use MaaS" (*IV_39, $\mu = 3.65$, $\sigma = 0.983$*), factor ***cost incentives*** covered cost-related mechanisms of incentivising MaaS acceptance and use.

As in the case of added value, the discussed herein factor, via ordinal regression modelling, was found to be significantly, and positively, correlated with all six studied travel behavioural intentions. Car ownership decisions have been long known to be influenced by car purchase costs, costs of car use, and fares of alternative transport modes (Dargay, 2002). In a way supporting the above, the quantitative phase findings suggest that ***the more transport users are driven by the cost benefits integrated MaaS travel may potentially offer, either in the form of reduced overall transport spending or in the form of governmental reliefs and motives, the***

more likely they are not to own a car when equipped with MaaS (*Model One, β = 0.846, p < 0.05).* Also, ***these transport users are more likely to use public transport based multimodal offering for their commute*** (*Model Five, β = 0.817, p < 0.05)*.

Public transport is known to beat car use in terms of cost (Beirão & Sarsfield Cabral, 2007), and, offered in combination with other transport alternatives for the same or even cheaper price and supported by government incentives, is likely to be seen as an even more attractive means of travel. Yet again, however, ***transport users who fall at a higher level of likelihood of being influenced to use MaaS by cost benefits are also more likely not only to replace public transport trips by publicly shared cars*** (*Model Two, β = 0.513, p < 0.05*) ***and commute by publicly shared cars, both on individual basis*** (*Model Three, β = 0.841, p < 0.05*) ***and for collective use*** (*Model Four, β = 0.426, p < 0.05),* ***but also to travel more*** (*Model Six, β = 0.678, p < 0.05).* Thus, giving affordable access to a multitude of mobility options, and car-based shared use modes in particular, at no "extra" cost to get transport users out of personal cars, whilst reducing car ownership and personal car use, may result in an increase of shared vehicle fleet in order to meet demand, and also facilitate the growth of vehicle kilometres travelled (Pangbourne et al., 2020), similar to the case of added value.

6.3.6. Past Behaviour

(I) Via an extensive literature review, past behaviour, in the form of past experience with personal cars but also experience with all the alternative to personal car modes of transport, included in MaaS, was found to be a driver of MaaS acceptance and travel behavioural response to MaaS. In this study, the author tested how past behaviour, and particularly the frequency with which different transport modes are used, affects MaaS acceptance and travel behavioural intentions. Via ordinal regression modelling, availability of car in the household, or ***car ownership***, ***frequency of using private car as a driver***, ***frequency of using public transport***, but also ***publicly shared cars for both individual and collective use***, and the ***frequency of using private car as a passenger*** were found to affect travel behavioural intentions with MaaS.

(II) Via ordinal regression modelling, ***car ownership***, alongside other factors, was found to be significantly, and positively, correlated with two travel behavioural intentions, namely the intention "With MaaS I would consider not owning car" (*Model One, β = 0.816, p < 0.05),* and

the intention "Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment" (*Model Six, β = 0.638*, *p < 0.05).* Given that the base category for car ownership item was the presence of the car in the household, the latter first of all means that ***transport users who do not currently own a car are more likely not to own a car in the MaaS era, as opposed to those who are in possession of one (or more).*** This supports the findings of Kamargianni et al. (2018) that non-car-owners are more willing not to own a car when equipped with MaaS than the car-owning individuals.

It is also known that carless individuals are limited in physical distance and spatial range of their travel and, thus, choose activities located in their neighbourhoods or easily accessible by public transport (Lagrell et al., 2018). By using MaaS, non-car-owning individuals may benefit from access, alongside other modes, to a car, a mode whose perceived convenience outweighs any other alternatives', without the hassle of owning it and at a fixed monthly price. This potential of MaaS bundles to save costs and shift resource availability, as suggested by Weis & Axhausen (2009), may induce additional demand for the transport infrastructure due to an increase in propensity of participating in out of home travel activities, as well as their number, duration and the distance travelled. Supporting the above, the results of this study suggest ***that MaaS-based travel practices of individuals who do not currently own a car are more likely to generate additional travel than those of car-owning individuals***.

Daily use of private car as a driver was found to be significantly, and negatively, correlated with the travel behavioural intention "With MaaS I would consider not owning a car" (*Model One, β = -0.718*, *p < 0.05).* Given that the base category for this item was never using a private car as a driver, the latter means that ***transport users who drive their own car on a daily basis are less likely not to own a car when equipped with MaaS than the individuals who never drive.*** Thus, daily car use, on top of negatively affecting MaaS acceptance, as previously suggested in a number of MaaS related studies (Ho et al., 2018, 2020; Fioreze et al., 2019; Biehl & Stathopoulos, 2020; Caiati et al., 2020), also has a negative implications for MaaS' car ownership reduction goals.

As for ***public transport***, using the latter ***once a week*** was found to be significantly, and positively, correlated with the travel behavioural intention "With MaaS I would replace some pf my public transport trips with publicly shared cars" (*Model Two, β = 1.477*, *p < 0.05),* while

more frequent or less frequent use were not found to have a significant impact on any of the studied intentions. Given that the base category for this item was never using public transport, the latter means that ***transport users who use public transport once a week are more likely than those who never use it to replace public transport trips with publicly shared cars when equipped with MaaS***. This adds to the findings of Alonso-Gonzalez et al. (2020) suggesting that individuals using some kind of public transport on a weekly basis are more likely to adopt MaaS for their travel but are also more likely to use the tool for accessing car-based mobility services in place of public transport, this way developing unsustainable travel behavioural practices.

Individual use of publicly shared cars at least once a month was found to be significantly, and positively correlated with travel behavioural intention "With MaaS I would replace some of my public transport trips with publicly shared cars" (*Model Two, β = 0.532*, *p < 0.05)* and travel behavioural intention "I would use MaaS and commute by a publicly shared car for the whole journey as long as I have it for my own use" (*Model Three, β = 0.452*, *p < 0.05).* Given that the base category for this item was never using publicly shared cars for individual use, the latter means that ***transport users who have experience using publicly shared cars on individual basis once a month or more are more likely to replace public transport trips with publicly shared cars, or to commute by publicly shared car for the whole journey on individual basis, when equipped with MaaS, than individuals who never use these services***.

The ***collective use of publicly shared cars*** was found to be significantly, and positively, correlated with the travel behavioural intention "With MaaS I would replace some of my public transport trips with publicly shared cars", both on rare occasions (*Model Two, β = 0.666*, *p < 0.05)* and at least once a month (*Model Two, β = 0.806*, *p < 0.05).* Given that there was a total of three categories, and the base category for this item was never using publicly shared cars collectively, the latter means that ***transport users who share public cars with strangers are more likely to replace public transport trips with publicly shared cars when travelling with MaaS than those who never use those services.*** These findings related to the use of publicly shared cars on both individual and collective basis support previous MaaS research, where experience with publicly shared cars was found to have an influence on the acceptance of MaaS (Alonso-Gonzalez et al., 2020; Caiati et al., 2020), also in a bundle form (Ho et al., 2020), but again suggest that individuals with the experience of using such services are the ones likely to not only include these modes in their MaaS subscriptions, as recognised

by Matyas & Kamargianni (2018), but also develop unsustainable, car-dependent, travel behaviours.

Finally, the ***use of private car as a passenger on a daily basis*** was found to be significantly, and negatively, correlated with the travel behavioural intention "I would use MaaS and commute by a publicly shared car for the whole journey sharing it with people I don't know" (*Model Four, β = -1.368*, *p < 0.05).* Given that the base category for this item, similarly to the above, was never travelling by car as a passenger, the latter means that ***transport users who travel by household car as a passenger every day are less likely to share public cars with strangers for their commute when equipped with MaaS.*** This adds to the findings of Caiati et al. (2020) and Feneri et al. (2020) regarding the effect of private car passengers' travel practices on the acceptance and use of MaaS.

6.3.7. Household Income

(I) Although a number of socio-demographic features affecting the acceptance and travel behavioural response were identified through the literature review and tested in this study, only ***household income*** was found in some way to affect the studied herein travel behavioural intentions.

(II) Via ordinal regression modelling, low annual household income of up to £15,000 was found to negatively affect the intention "I would use MaaS and commute by public transport combined with other transport options" (*Model Five, β = -0.926*, *p < 0.05),* meaning that ***falling into a low-income category decreases the chances of transport users going for public transport-based commute with MaaS.*** Given that the UK has some of the most expensive public transport services in the world (De Clerk, 2019), and how in their discussions qualitative phase participants were certain that travelling by car was cheaper than using public transport, the reluctance of low-income transport users to use public transport is expected.

Having an annual income of £75,000 and above was negatively associated with the intention "Overall, I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment", meaning that falling into high-income category decreased the chances of individuals to travel more using MaaS bundles, counter to previous research where income growth was argued to add to the traffic by increasing the number of trips as

well as trip length (Paulley et al., 2006). In line with Veternik & Gogola (2017), this probably means that, ***when equipped with MaaS, high-income transport users may not increase the number of trips, or the distances they travel as they are able to allocate more funds for travelling than low-income transport users and, therefore, travel as often and as far as they wish already without MaaS.***

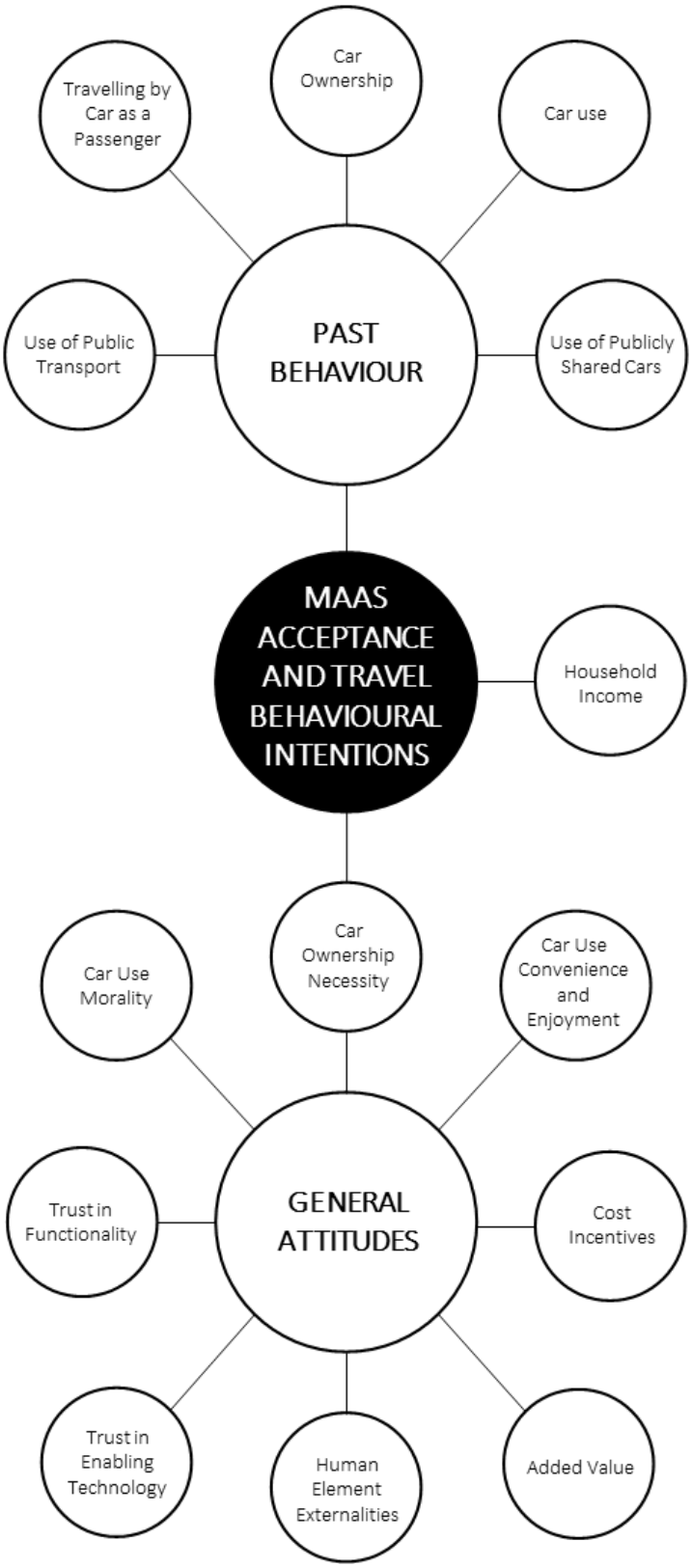
6.4. Conclusions

Based on the above discussion it can be concluded that car use convenience and enjoyment, car ownership necessity, car use morality (or the lack of it), trust in functionality, trust in enabling technology, but also human element externalities are the barriers to MaaS acceptance and, more importantly, to its sustainable use. MaaS features and functionalities that, according to the participants, form the added value of MaaS represent the window of opportunity to promote MaaS' sustainable uptake. Moreover, appropriate use of costing strategies and financial incentives, as suggested by the factor cost incentives, should be adopted in order to make MaaS an effective tool for enabling sustainable travel practices among its users.

It was also confirmed, however, that past experiences with travel options included in the MaaS offering, do have an influence on sustainable uptake of MaaS, and the use of these specific modes of transport via MaaS platforms specifically. Socio-demographics, despite being widely recognised in the literature as the drivers of MaaS acceptance and use, with the exception of household income, were not found to directly influence MaaS acceptance and travel behavioural intentions. Therefore, these should also be considered when promoting sustainable use of MaaS.

Figure 6.4.1 is the final conceptual framework that results from the combination of findings of the literature review and the qualitative and quantitative inquiries, presented in this thesis; it represents the factors driving MaaS acceptance and travel behavioural intentions, both with positive and negative influence on the latter. This framework could be used by policy makers and mobility providers as a starting point for designing policy and business strategies to support sustainable travel with MaaS platforms.

Figure 6.4.1: Mixed Methods Enhanced Conceptual Framework



CHAPTER 7. CONCLUSION

7.1. Introduction

This Chapter is a synthesis of selected critical evidence designed to highlight the key messages and the unique contributions to knowledge in the field of MaaS that the present PhD Thesis offers. More specifically, it looks into revisiting the factors that influence MaaS acceptance and travel behavioural intentions. The section recognises and contextualises the important roles of car ownership necessity, car use convenience and enjoyment, car use morality, trust in MaaS functionality and enabling technology, human element externalities, added value, and cost, but also past behaviour and income level. The policies based on the evidence provided and aimed at reducing negative effects of MaaS transition are provided. The unique contributions to theory, practice, and methodology are also highlighted. Furthermore, this chapter reflects on overall research process, indicates research process limitations, and discusses the possible improvements to the project be the generated knowledge available at the study initiation stage. Future research agenda completes the chapter.

7.2. Fulfilling the Aim of the Thesis: Key Results and Policy Implications

The overall aim of the research presented in this thesis was *to develop the empirical understanding of potential travel behavioural implications of MaaS identifying opportunities and challenges in its ability to create sustainable travel behavioural change and produce evidence-based recommendations for policy makers and mobility providers to support sustainable travel behaviour with MaaS*. A comprehensive literature review resulted in an identification of possible unsustainable travel behavioural outcomes of MaaS introduction and also highlighted the importance of understanding the drivers behind travel behavioural intentions in order to support travel behaviour sustainability via appropriate policy. The literature review also resulted in the development of a conceptual framework explaining MaaS acceptance and travel behavioural intentions. According to this framework, travel behavioural intentions with MaaS are driven by individual attitudes, but also past behaviour, and socio-demographics. Forty semi-structured interviews with UK based transport users were conducted in order to elicit the specific attitudes that drive MaaS acceptance and travel behavioural intentions. A data-intensive thematic analysis uncovered five themes representing individual attitudes that drive MaaS uptake: *car dependence, trust, human element externalities, added value,* and *cost*. These key attitudinal drivers were

tested, alongside past behaviour items and socio-demographic attributes, via statistical analysis, employing descriptive and ordinal regression approaches, of a survey with 427 responses of UK transport users. The results of this mixed-methods research contribute to the empirical understanding of MaaS as tool with the ability to create sustainable travel behaviour change, and to policy development for ensuring sustainable uptake of MaaS.

Thus, it can be concluded that MaaS as a whole seems to be portrayed as an attractive mechanism with the majority of study participants expressing interest in using the service in both pay-as-you-go and bundle formats; high interest in the service, however, does not guarantee the desired travel behavioural change, to the extent, where transport-caused sustainability challenges could be overcome. Owning a car before MaaS as well as daily driving lower the potential of MaaS to create transport future free of private cars. Car ownership is still considered necessary, at least for the cases of emergency and disruption, which would be hard to manage even with fully functioning MaaS. Moreover, a personal car to this day serves as a status symbol and as a means of demonstrating success to peers. These perceptions of owning a car, unfortunately, also limit the prospects of MaaS as a tool able to reduce car ownership levels. It is not car ownership attitudes alone, however, but the general dependence on cars that hinders sustainable uptake of MaaS. So, perceiving the travel by car, and not just personal, as convenient and enjoyable also has its implications for MaaS uptake: those, holding positive attitudes towards using a car, with MaaS are likely to choose car-based shared use mobility services for individual use for some of their most frequent trips, like daily commute, and also substitute public transport journeys with publicly shared cars. Limited moral considerations regarding the environment, perceptions of car having little to do with climate change and having no implications for overall congestions levels, though less prevalent among transport users than other car related attitudes, also increase the likelihood of them choosing car-based shared use mobility services for regular commute.

Therefore, transport users' attitudes not only towards car ownership, as suggested by Mulley (2017), but also car use in general, and especially its implications in environmental terms, must change to ensure sustainable transport choices are made when shifting to MaaS based travel. This could be achieved, as proposed by study participants themselves, by government-led "push" motivating strategies, such as environmental laws and excessive charges for personal car use and ownership. More specifically, these could include rises in fuel prices and parking charges alongside time- and place-based tolls, but also restricted car access, reduced or eliminated parking spaces, and lower speed limits (Stradling et al., 2000). These strategies, though, are often met with public

opposition; this, however, could be overcome through increasing environmental awareness in public (Loukopoulos et al., 2005). A MaaS platform itself could be used as an environmental education means by offering transport users more sustainable travel options whilst also informing them of their carbon footprint and congestion contribution. The use of such motives in online journey planning and smartphone applications has already proved to result in more sustainable travel choices among transport users (Brazil et al., 2013).

This study's participants initially noted the many issues that could hinder the provision of transport services via a MaaS digital interface. Lack of trust in information provision but also cyber-security functions of MaaS, such as protection of personal data and monetary transactions, alongside individual readiness to use smartphones and applications, via quantitative investigation, however, appeared not to be of significance for MaaS acceptance and use. Nevertheless, these issues should be considered by policy makers and transport providers to ensure successful and sustainable MaaS transition. First, businesses partaking in MaaS not only need to be GDPR compliant and process sensitive user data in accordance (Murati, 2020), but also make their compliance explicit to transport users. Given that study participants often expressed trialing MaaS as a means of accepting the service, transport providers and policy makers need to test out and work on improving MaaS through the use of pilots, trials and living labs; this will give a window of opportunity to users to familiarise with the novel tool and the means of its provision, thereby helping overcome the digital readiness concerns, and abolish negative (usually unsustained) perceptions about information provision risks that a real-life scheme application would make apparent that they should not exist.

Concerns with mobile device battery life and quality of internet coverage around travel area lowered transport users' willingness to accept and use MaaS. According to this study's findings, transport users concerned with the latter issues are less likely not to own a car when transitioning to MaaS, or to choose public transport based multimodal commute. To make the attitudes towards non-car-based travel more positive and overcome the MaaS enabling technology issues, alternative means of access to MaaS must be provided (Polydoropoulou et al., 2020a). Whilst the access to transport offering within MaaS could be backed up with the use of smart cards, for example, offering off-line access to real-time information services remains a challenge. Digital information boards optimally located at interchange points, but also street maps and increased signage aimed at orientating transport users on the street (Ibraeva & Figueira de Sousa, 2014) could help

eliminate some of the risks associated with the loss of access to information via smartphone applications.

It is also due to the contemporary social environment that the MaaS paradigm may not develop sustainably: both transport staff and users, according to study participants, show little respect to rules, transport infrastructure, and even each other, generating concerns around sharing the means of transport with others. These concerns also lower the likelihood of transport users not to own a car and decrease the chances of transport users to commute by public transport combined with other transport options when equipped with MaaS. However, these concerns also decrease the chances of transport users to substitute public transport trips with car-based shared use mobility services or to commute unimodally by services like ride-sharing. The value-adding account and feedback mechanisms of MaaS may overcome the human element externalities and help in making sharing the means of transport more trustworthy and, therefore, acceptable, as these provide the means for identifying an individual in case of crime or other issues occurring. The crowding and urban security information, provided via MaaS apps, could help the most concerned with these issues transport users to avoid travelling at times when they could feel most susceptible to harm. The public transport means themselves, however, should be equipped with surveillance tools, like CCTV, more widely, and the means of easy and fast communication with police should be provided. Besides, the drivers of both public transport and shared use mobility means, and ride-hailing in particular, should be certified and trained with the customer satisfaction being the top priority when delivering the service. These, perhaps, could also help regular private car passengers to open up to shared means of transport within MaaS offering – something they are currently reluctant to do.

On top of the capacity of MaaS to break existing travel habits and its ability to mitigate some of the transport sharing risks, this study's participants also recognised MaaS potential to induce improvements in the level of service provision, eliminate transport capacity bottlenecks via its analytical functions, and offer incentives, such as travel-related discounts and bonus points, as features of value. These, alongside the potential of MaaS to reduce overall travel spending, have a strong positive effect on the acceptance of MaaS. The appreciation of these features, however, may result in both sustainable, such as car ownership reduction and increased public transport usage, for commute at least, but also unsustainable travel behavioural outcomes, such as substitution of public transport with publicly shared cars, reliance on publicly shared cars for commute in place of current modes, and trips and miles surplus. These unsustainable travel

behavioural intentions, with the exception of induced travel, were also found to be stronger among weekly public transport users and those experienced with the use of publicly shared cars. This likely indicates transport users' dissatisfaction with the public transport service and the consequent desire for access to convenience of cars without the hassle of ownership. Therefore, value-adding features and the cost structure of MaaS should be organised in a way that promotes the use of public transport and active travel modes not only over private car but also over car-based shared use mobility services.

The idea behind MaaS should not be that of beating private car convenience, as widely proposed in existing MaaS research, but to outweigh the benefits of general car-based travel by creating a multimodal travel option that offers the opportunity to transport users to be part of an initiative designed to create more liveable, socially inclusive, and sustainable futures. Thus, transport users should be incentivised to travel responsibly with MaaS through not only excessive charges, but also bonuses and tax reliefs. The next step for transport providers and policy makers should be to make public transport the backbone of any MaaS system. Therefore, major efforts should be put into encouraging integrated, demand-responsive, timely and, given the discovered by this study unwillingness to use these services among low-income transport users, inexpensive public transit networks. This can be achieved through seamless integration of a variety of transport modes, enhanced with well-timed, reliable, and honest information provision, all to satisfy the very diverse user needs. Services like carsharing and ride-sharing should be made less accessible in contrast, via monetary disincentives, and perhaps provided primarily for emergencies and as neighbourhood feeders to mass-transit systems. The reliance of transport users on public transport rather than private cars or car-based shared use mobility services may also reduce the negative effects of induced trips (Alyavina et al., 2022). But the marginalisation of car solutions embedded in this sustainability-enhancing approach might go against the usual MaaS rhetoric of "individual unfettered freedom" (Pangbourne et al., 2020). So, the society of the future, and the research community, should be facing a dilemma: "do we want a genuinely sustainable MaaS?" or "one that is more easily accepted but might be uberised?" (Alyavina et al., 2020).

7.3. Key Contributions of the Research

Making an original contribution to knowledge in a particular academic field remains one of the main criteria for the award of a doctorate degree (Oliver, 2013). Thus, this section highlights the

theoretical, practical, and methodological contributions the work presented in this thesis has made, and how those add to the existing knowledge in the MaaS field.

7.3.1. Contributions to Theory

One of the key contributions of the research presented in this thesis is the development of a set of factors that influence MaaS acceptance and, more specifically, travel behavioural intentions with MaaS. Via literature review a lack of knowledge regarding MaaS travel behavioural implications was established. There is a growing number of studies focusing on the acceptance of MaaS either in pay-as-you-go or bundle formats, with some also looking at choices of transport modes within bundles. There is also a number of pilot studies that in part focus on travel behaviour change with MaaS. None of them, however, focus explicitly on unsustainable MaaS potential. Moreover, a number of studies propose attitudinal, past behavioural, and socio-demographic factors influencing MaaS acceptance; those, however, are different from study to study, and yet again do not focus specifically on possible unsustainable travel behavioural outcomes of transition to MaaS.

Thus, this research contributes to theory development by first identifying the broad set of drivers of MaaS acceptance and, possibly, use via an extensive literature review. Having established a preliminary conceptual framework of MaaS acceptance and travel behavioural intentions, comprising of general attitudes, past behaviour, but also socio-demographic features as possible drivers, this research further develops the generated theory by applying qualitative methodology. Qualitatively, a comprehensive set of attitudes that drive MaaS acceptance and travel behavioural response was identified. These were then tested quantitatively, alongside past behaviour and socio-demographic items, against travel behavioural intentions to create the models of intentional travel behaviour formation with MaaS. Thereby, this study provides theoretical contributions to the existing MaaS literature by explaining unsustainable travel behavioural outcomes potentially following the transition to the concept. The main findings of this study, namely the framework putting together a set of factors driving MaaS acceptance and travel behavioural intentions, although to an extent complimentary to the existing literature, provides this extended knowledge in a format that makes it easily applicable to study travel behavioural intentions with MaaS in other contexts.

7.3.2. Contributions to Practice

This mixed methods research, resulting a framework explaining potential unsustainable travel behavioural outcomes of MaaS transition, has implications for policy makers and transport and mobility provides involved in the implementation of MaaS. This research, therefore, highlights the importance of carefully selecting an approach to MaaS proposition that would support responsible travel among its users. The models establishing the relationships and dynamics between the driving factors and MaaS travel behavioural intentions could be used to design MaaS offerings that guarantee sustainable travel, but also to establish supporting policy and governing strategies. This study also highlights some policies and strategies, concerning the MaaS offer itself but also the wider environment where it is to function, which could be helpful in making MaaS an effective tool for enabling sustainable travel behaviour among its users.

7.3.3. Contributions to Methodology

Although a sequential mixed-methods research design, with qualitative phase preceding and informing the quantitative inquiry, has been previously used in the MaaS research (e.g., Schikofsky et al., 2020), and the methods of data collection and analysis applied are not in themselves new, the methodological approach used in this research is a unique combination of methods that has not yet been utilised for the study of MaaS and its travel behavioural implications. More specifically, this study contributes to the methodological approaches used in MaaS research by utilising Braun & Clarke's (2006) Thematic Analysis for eliciting transport users' attitudes towards the concept from the data collected via individual semi-structured interviews, and by subsequently developing a thematic map of MaaS attitudes that drive MaaS acceptance and travel behavioural intentions. This study further contributes to the methodology in MaaS by refining the developed qualitatively thematic framework via exploratory factor analysis (EFA), or, more precisely, principal component analysis (PCA). As the last step in the analysis, an ordinal regression modelling technique was applied to establish the causal effect of the elicited attitudinal factors, but also identified via literature review past behaviour and socio-demographic attributes, on travel behavioural intentions with MaaS. The need for ordinal regression analysis also highlights the fact that the survey instrument used at the quantitative phase of the research is unique in a way that it uses ordinal variables, with five-point Likert-scales measuring the likelihood of travel behavioural intentions occurring, this way differing from previous survey-based MaaS studies using stated preference, or stated choice, experiments.

Another aspect of this study that contributes to methodology in MaaS user research is the sample used, for both qualitative and quantitative phases. Interview-based qualitative studies of MaaS attitudes have previously taken place in Sweden (Sochor et al., 2015; 2016; Strömberg et al., 2018; Hesselgren et al., 2020), Netherlands (Fioreze et al., 2019), Germany (Schikofsky et al., 2020), and several EU countries simultaneously (Polydoropoulou et al., 2020b; Wright et al., 2018; 2020). Only one interview-based attitudinal MaaS study took place in the UK (Matyas, 2020); this study, therefore, adds to the body of qualitative MaaS research in the UK context. The qualitative phase sample, as should be noted, also exceeded the London-based study's one in terms of number of transport users taking part. The quantitative survey sample is unique in a way that it focused on the UK general public comprising of respondents from England, Wales, and Scotland, from urban, suburban, and rural areas around the countries. Interestingly, previous survey-based MaaS studies of the UK context were either single-city-based, e.g., London (Kamargianni et al., 2018; Matyas & Kamargianni, 2018) or Manchester (Polydoropoulou et al., 2020a), or region or county based, e.g., Tyneside (Ho et al., 2020) or West Yorkshire (Harrison et al., 2020a).

7.4. Reflections and Limitations

Although adopting systematic practices when reviewing the existing body of the literature, and utilising a number of qualitative, quantitative, and mixed-methods rigour strategies when collecting, analysing, and interpreting data, this research has its limitations. This section reflects on each stage of the research process acknowledging their limitations but also justifying the choices made.

7.4.1. Literature Review

The literature review was the step undertaken in this research in order to highlight the knowledge gap but also to set the direction for further investigation. As mentioned in Chapter 2 Literature Review, the reviewing process was concerned with finding out what was known about MaaS acceptance and its potential travel behavioural outcomes, and consequently with establishing a preliminary framework of factors that influence MaaS acceptance and travel behavioural response. Adopting some of the principles presented in works by Van Wee & Banister (2016), Knowles et al. (2020), Nikitas (2019), and Nikitas et al. (2020), the literature review was founded on peer-reviewed journal articles, conference papers, and industry reports, discovered via accessing Scopus database, but also using snowballing techniques and general Google search.

The literature review process was rather challenging, first due to the fact that the number of conceptual, review, and empirical items referring to MaaS, and its user perspective in particular, has grown rapidly in the few months preceding the submission of this thesis. Although the author tried to capture the long-known but also very recent findings, the updating process had to be ceased at some point to allow time for finalising the thesis. It is important to mention, however, that the literature was also enriched post analysis, and some new literature items can be observed in the Discussion Chapter of the thesis. The author does acknowledge, though, that some of the more recent studies might not be captured by the literature review. The author also acknowledges that the literature review is based only on the literature that was accessible (e.g. not restricted financially) at the time of the review. Moreover, the literature review does not include book chapters or an excessive number of industrial reports that may have included additional insights regarding MaaS acceptance and the drivers behind its acceptance and use. The keywords used in the search, namely "Mobility as a Service" and "Maas", could be not present in some items containing relevant insights. Yet, the literature review captures a wide variety of sources with diverse, and at times contradicting, results in terms of MaaS acceptance and travel behavioural implications, but also the driving forces behind the latter. Thus, despite a number of limitations, the findings of the literature are comprehensive and sufficiently cover the state-of-the-art user perspective research in MaaS focusing on its acceptance and possible travel behavioural outcomes.

7.4.2. Qualitative Phase and Analysis

The qualitative phase of this research comprised of individual semi-structured interviewing, with the collected data analysed following Braun & Clarke's (2006) Thematic Analysis principles, highlighted in the work of Nikitas et al. (2018; 2019). This was a rigorous approach not only due to analytical steps undertaken following the guidelines from reputable literature but also due to the author explicitly covering the steps for achieving qualitative rigour, developed specifically for this study, and presented in Chapter 3 Methodology (the way each of the steps towards rigour were covered is described in detail in Chapter 4 Qualitative Phase and Analysis). Yet, however, the qualitative inquiry of this thesis has its limitations. First of all, the Thematic Analysis is a rather flexible qualitative analytical approach that does not pertain to any philosophical stance; therefore, the way the data is analysed will always reflect the researcher's ontological, epistemological, and paradigmatic ideas and values. The strategies for verifying the qualitative research process and achieving internal validity and reliability of findings have all been used to ensure that the data coding, although analyst-driven, is a result of scrupulous work, while peer-review from author's

supervisors was there to confirm that the way the author interpreted the collected data was not entirely subjective, and that similar results could be generated also by other researchers. What is more important, however, is that the qualitative results of this study have already been published and, therefore, approved by a prestigious journal (see Alyavina et al., 2020).

What also needs to be acknowledged is the fact that, although significantly exceeding the recommended sample size for interviews and also providing enough data to have achieved saturation, the sample of UK based transport users partaking in this qualitative study cannot report the unbiased universal reality; a different selection of transport users may have resulted in different outcomes for this inquiry. Also, the sample is slightly overrepresented by male participants which may generate some bias, too. Moreover, a rather small sample size, which is natural to qualitative investigations, may result in the qualitative findings not being generalisable (or, in qualitative terms, transferable) to other or broader contexts. This limitation is, in a way, overcome in this study as the qualitative findings are tested via questionnaire on a much larger scale at the quantitative phase.

7.4.3. Quantitative Phase and Analysis

An approach to quantitative inquiry in this thesis was similar to the one used at the qualitative phase, with an explicit set of rigour strategies, presented in Chapter 3 Methodology, carefully followed, and fulfilled. It has to be noted, however, that both Pearson Chi-square Tests and Deviance statistics should be used only with expected values in each cell being reasonably large. The six models tested in this quantitative inquiry all received a warning, generated by SPSS, regarding the presence of empty cells, or cells with zero frequencies, in designs. The latter often occurs due to using continuous explanatory variables in the modelling (Norusis, 2012), which applies to the factors representing attitudinal drivers in the six models developed here. Therefore, the Pearson Chi-square Test and Deviance statistics, although delivering the desired insignificant results, were interpreted with caution, and the selection of models, first of all, was determined by the results of the Likelihood Ratio Chi-square Tests and the Tests of Parallel Lines.

The approach to modelling at the quantitative phase of this research was rather experimental, trial-and-error-like, with different models generated using the same set of attitudinal variables. When studying the behavioural outcomes, however, it is advised to have the behaviours clearly defined in terms of target, action, context, and time elements, and the attitudinal determinants elicited

questioning individuals regarding this specific behaviours (Ajzen, 2019). The behaviours, or intentional behaviours, studied herein were rather broad, and while the action, and context for some of them, were defined, there was no specific time-frame or target set. Moreover, the attitudinal drivers used in the modelling pertain to a multitude of intentional behaviours, as per qualitative inquiry. This in a way explains why not all qualitatively established attitudes resulted in statistically significant relationships with the studied intentions. The work presented in this thesis, however, is the first attempt to study possible unsustainable travel behavioural outcomes of transitioning to MaaS transport paradigm explaining the driving forces behind the latter; the work demonstrates that the generated set of driving forces behind MaaS applies one way or another to different unsustainable travel behavioural intentions with MaaS, and thereby serves as a solid starting point to those willing to understand those intentional behaviours individually and in more detail. It is also important to note that, despite the above-mentioned limitations, the modelling attempts resulted in rather strong models of intentional behaviours, with some of them achieving Cox and Snell *pseudo*-R^2 with Nagelkerke correction values either very close to or even exceeding 0.4, which, according to previous modelling studies (e.g. Nikitas et al., 2018) is a rather strong association of predictor variables with dependent variable, especially when the modelling itself was not based on previously established behavioural theories. The models with lower values for Cox and Snell *pseudo*-R^2 with Nagelkerke correction, while having weak association of predictors variables with dependent variables, are still informative and useful as they demonstrate the effect on intentions of variables that did not appear significant in stronger models, for example, *car use morality*.

Furthermore, the fact that the data collection instrument, used at the quantitative phase, was web-based, has to be recognised. One of the biggest issues with web-based research is the quality of sample. For an instance, although a wide variety of socio-demographic features were collected via the developed questionnaire, this information may be questionable, so relatively little is known about the characteristics of respondents. Moreover, non-response rate tracking is difficult to ascertain as the survey is accessible by a wide variety of people and the population cannot be precisely defined. Another major limitation, associated with web-based survey, is the self-selection bias, meaning there is a tendency of some individuals to respond to an invitation to participate in a web-based questionnaire and for others to ignore it. Yet, the web-based sample was easier and less expensive to obtain, which is important given the absence of funding for the research presented in this thesis. Although the sample obtained, as mentioned in Chapter 3 Methodology,

may be biased and, for this reason, non-representative of the population studied, it is still valuable as it represents a subgroup of the population.

7.5. Suggestions for Future Research

Only the direct relationships of the identified set of attitudinal, socio-demographic, and past behaviour variables with a number of MaaS travel behavioural intentions were studied, via ordinal regression modelling, at the quantitative phase of the research, presented in this thesis. Thus, a suggestion for future researchers is to experiment with structural equation modelling approach and test whether some of the identified variables have a mediating effect; for example, a more significant role of individual socio-demographics could be established using the above-mentioned modelling approach as these variables, although not having a direct effect on travel behavioural intentions with MaaS, may determine individual MaaS-related attitudes, as in the case of the study by Mola et al. (2020).

As mentioned previously in the Reflections and Limitations section, the work presented in this thesis focused on a wide range of unsustainable behavioural intentions with MaaS. Future research could focus more specifically on each individual travel behavioural intention, qualitatively enhancing the set of attitudes, developed herein, for each specific intention and also testing the effect of those quantitatively using regression modelling or structural equation modelling techniques. Moreover, through the use of MaaS pilots and MaaS travel diaries, future research could study, with the mediating effect of intentions, the actual behavioural changes among transport users.

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APPENDIX I: SURVEY

Dear Participant,

Can you imagine being able to combine public transport, taxi, ride sharing, bike sharing and other mobility services into a single connected offering? Do you think you could simply and easily plan, purchase and travel using the most convenient route and vehicle for your trip? Mobility as a Service (MaaS) offers such opportunity and is central to the research you are being invited to take part in.

The survey you are about to begin should take around 15 minutes of your time but will help us highlight opportunities and challenges referring to the uptake of MaaS. Don't worry if you are not very familiar with the concept: within the survey, you will be provided a detailed description of MaaS, which will help you answer the questions.

For your comfort, it is better if you fill in the survey using your PC, though it is also possible to do it using your smartphone. Be assured that all your answers are anonymous and will be kept in the strictest confidentiality. The information collected will be kept in secure conditions for a period of 5 years at the University of Huddersfield, and no person, other than the researcher and facilitators, will have access to the information you provide.

Your contribution to this research is entirely voluntary, and you have the right to withdraw from the research at any point without giving explanations.

In case you have any concerns about this study or wish to complain, please contact the researcher Elena Alyavina at *elena.alyavina@hud.ac.uk.*

If you are satisfied that you understand the information, and are happy to take part in this project, click on arrow to begin.

Q0.1 Do you currently live in the UK?

o Yes

o No

Skip To: End of Survey If Do you currently live in the UK? = No

Q1.1 Please, write down the name of the village/town/city/etc. you currently live in:
_____

Q1.2 Do you have a full car driving license?

o Yes

o No

Q1.3 Do you have a car in your household?

o Yes

o No

Q1.4 What is your current status of employment?

o Employed full time

o Employed part time

o Unemployed looking for work

o Unemployed not looking for work

o Retired

o Student

Q1.5 What type of residential area do you live in?

o Rural area

o Town centre

o Town suburb

o City centre

o City suburb

Q2 Please specify how often you use the following travel options.

	Daily	Few times a week	Once a week	At least once a month	Rarely	Never
Private car as a driver	o	o	o	o	o	o
Private car as a passenger	o	o	o	o	o	o
Public Transport Bus/Tram/Train/etc.	o	o	o	o	o	o
Cycling or bike sharing	o	o	o	o	o	o
Walking	o	o	o	o	o	o
Publicly shared car for my own use (Taxi/Uber/Zipcar/ etc.)	o	o	o	o	o	o
Public car shared with others (Taxi share/UberPool/ BlaBlaCar/etc.)	o	o	o	o	o	o

Q3 Please specify to what extent you agree with the following statements related to travel by car in general, either as a driver or a passenger.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I travel by car to have more predictable journey times	o	o	o	o	o
I travel by car because it is cost-effective	o	o	o	o	o
I travel by car because I can carry luggage/shopping/all the things I need without hassle	o	o	o	o	o

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I travel by car to avoid harsh weather	o	o	o	o	o
I travel by car because I feel safe this way	o	o	o	o	o
I travel by car to have the privacy I don't get on other means of transport	o	o	o	o	o
I travel by car to be independent of public transport	o	o	o	o	o
I travel by car because I enjoy driving/being in a car	o	o	o	o	o

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Q4 Please specify to what extent you agree with the following statements related to owning a car.

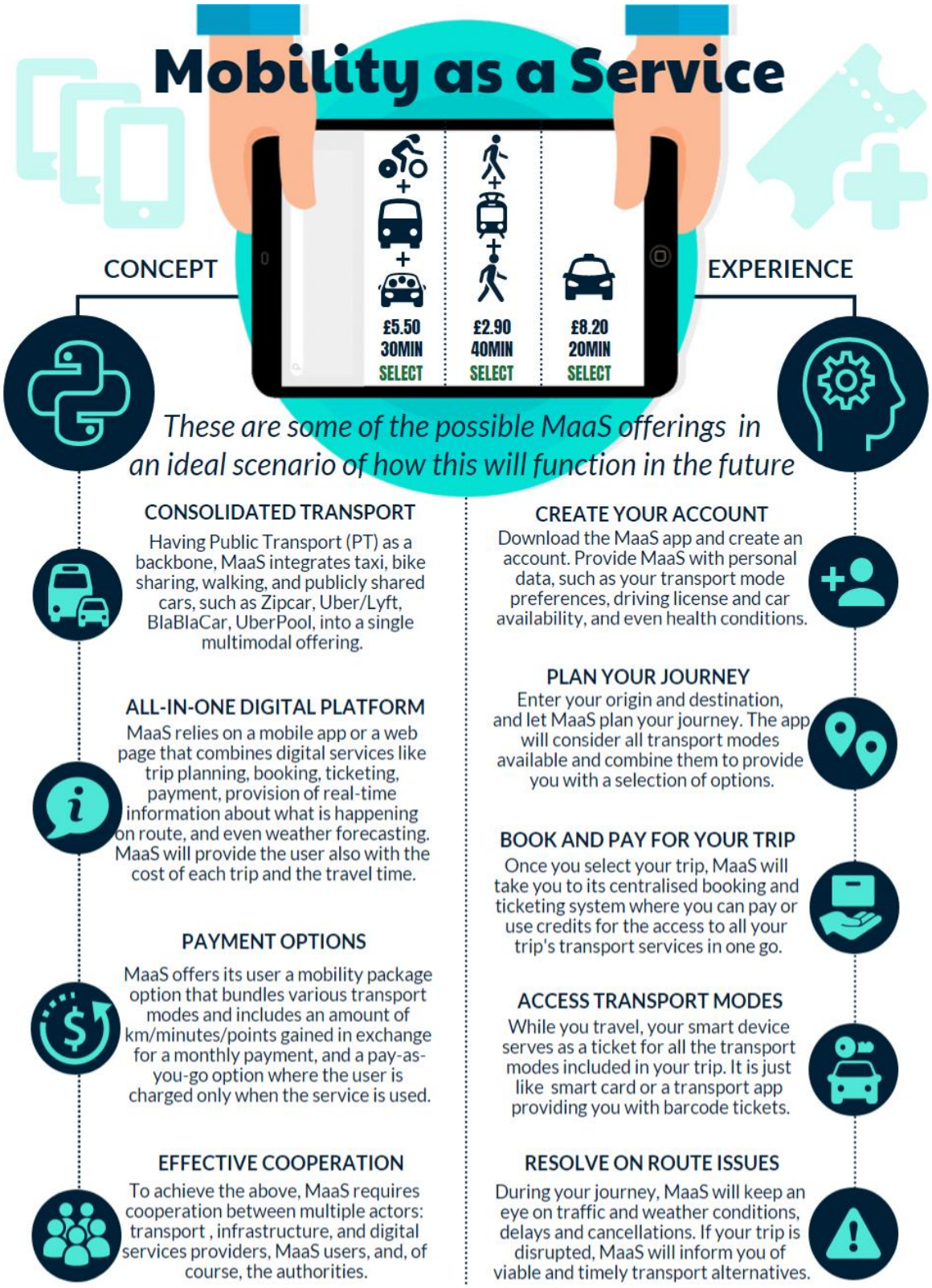
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
It's necessary to own a car if you have a family	o	o	o	o	o
I would own a car because people, important to me, also own cars	o	o	o	o	o
Owning a car is good because it's having your own thing	o	o	o	o	o
Having your own car is necessary for cases of emergency/ disruption	o	o	o	o	o

---

Q5 Please specify to what extent you agree with the following statements related to environmental issues.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The environment does not concern me	o	o	o	o	o
I think me using a car has little to do with climate change	o	o	o	o	o
I think congestion is not an issue for the environment	o	o	o	o	o

Q6 Please, read the below infographic and familiarise yourself with the concept of Mobility as a Service (MaaS). Once you are ready, move to the next section where you will be asked a set of questions related to the concept.



Q7 Please specify to what extent you agree with the following statements related to travelling with MaaS.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I would struggle to use a mobile device and an app to access different transport modes	o	o	o	o	o
I would worry whether my mobile device has got enough battery	o	o	o	o	o
I would worry about the quality of internet coverage where I am going	o	o	o	o	o
I would worry whether I am being charged correctly for my trips	o	o	o	o	o
I would not want to share my personal data with MaaS	o	o	o	o	o
Cyber-security behind MaaS system would concern me	o	o	o	o	o
I would not trust the travel information coming through the MaaS app	o	o	o	o	o
I would worry whether there would be a publicly shared car or bike available for me at the time I need	o	o	o	o	o
I would struggle to travel by a combination of transport modes	o	o	o	o	o
I wouldn't like to share the means of transport with people I don't know	o	o	o	o	o
I would stress about the inconsiderate behaviour of fellow travellers	o	o	o	o	o

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I wouldn't like to be in a crowded environment	o	o	o	o	o
Having to rely on other people for my transport would concern me	o	o	o	o	o

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Q8 Please specify to what extent you agree with the following statements related to the added value of MaaS.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I would use MaaS if I were informed about my contribution to reducing carbon footprint	o	o	o	o	o
I would use MaaS if I knew I was contributing to the re-duction of overall congestion levels	o	o	o	o	o
I would use MaaS if it offered me a more frequent and flexible public transport service day and night	o	o	o	o	o
I would use MaaS if I were informed about the availability of seats on different transport modes	o	o	o	o	o
If I could see, through MaaS plat-form, rating and feedback for driv-ers and fellow travellers, I would use MaaS	o	o	o	o	o
My decision to use MaaS would de-pend on the people who already used it	o	o	o	o	o

Q9 Please specify to what extent you agree with the following statements related to the cost of MaaS.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I would use MaaS if travelling with it worked out cheaper than what I currently spend on my transport	o	o	o	o	o
I would pay more for MaaS than what I currently spend on my transport	o	o	o	o	o
I would use MaaS if travelling with it would cost me about the same as what I currently spend on my transport	o	o	o	o	o
If government increased the cost of car ownership and private car use, I would use MaaS	o	o	o	o	o
If government offered financial re-liefs for switching from private car to MaaS, I would use MaaS	o	o	o	o	o
I would use MaaS if I were offered bonus points and dis-counts for trips through MaaS app	o	o	o	o	o

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Q10 Please specify how likely you would be to do the following if MaaS was available to you in its ideal scenario and at the price you are willing to pay.

	Extremely Unlikely	Unlikely	Neither Likely nor Unlikely	Likely	Extremely Likely
With MaaS I would consider not owning a car	o	o	o	o	o
I would travel to places I couldn't get to before if MaaS offered me transport options to do it	o	o	o	o	o

	Extremely Unlikely	Unlikely	Neither Likely nor Unlikely	Likely	Extremely Likely
I would travel more if MaaS gave me unlimited access to transport for a fixed daily/weekly/monthly payment	o	o	o	o	o
With MaaS I would replace some of my public transport trips with publicly shared cars (Taxi/Uber/UberPool/Zipcar/etc.)	o	o	o	o	o
I would use MaaS on a pay-as-you-go basis	o	o	o	o	o
With MaaS I would choose the daily/weekly/monthly package payment option	o	o	o	o	o

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Q11 Please specify how likely you would be to use the following travel options for your regular commute if MaaS was available to you in its ideal scenario and at the price you are willing to pay. *NOTE: Commute means travel to and from the place of work (if you are employed full/part time), place of study (if you are unemployed but attending a college/university) or your most frequent destination (if you are unemployed and not studying).*

	Extremely Unlikely	Unlikely	Neither Likely nor Unlikely	Likely	Extremely Likely
I would not use MaaS and travel as I used to	o	o	o	o	o
would use MaaS and travel by a publicly shared car (Taxi/ Uber/ Zipcar/ etc.) for the whole journey as long as I have it for my own use	o	o	o	o	o
I would use MaaS and travel by a publicly shared car (Taxi share/ UberPool/ BlaBlaCar/ etc.) for the whole journey sharing it with people I don't know	o	o	o	o	o

	Extremely Unlikely	Unlikely	Neither Likely nor Unlikely	Likely	Extremely Likely
I would use MaaS and travel by public transport combined with other transport options	o	o	o	o	o

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Q12.1 Who do you identify yourself as?

o Male

o Female

o Other

Q12.2 What age group do you belong to?

o 18-24

o 25-34

o 35-44

o 45-54

o 55-64

o 65+

Q12.3 What is your current level of education?

o Secondary School

o High School

o College

o Bachelor's degree

o Master's degree

o Doctorate

Q12.4 What is the rough annual income of your household after tax?

o £0-£15,000

o £15,000-£30,000

o £30,000-£50,000

o £50,000-£75,000

o £75,000+

o Prefer not to say

Q12.5 What is your marital status?

o Single

o Married/Domestic Partnership

o Divorced

o Widowed

o Prefer not to say

Q12.6 What is your family status?

o With children under 18

o With children over 18

o Without children

o Prefer not to say

Q12.7 Roughly how much do you spend on all your transport monthly (including car insurance/etc. if you own a car)?

o £0-£20

o £20-£50

o £50-£100

o £100-£200

o £200-£300

o More than £300

o Prefer not to say

End of Survey