# Policy, Regulatory and Commercial Considerations for the Implementation of a Mobility as a Service System

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# Abstract

Transport and access to mobility have been highlighted as a key factor in enabling economic growth and improving quality of life. However, widely used transport modes, such as private vehicles, also negatively impact cities and towns in several ways, including increasing congestion, poor air quality and leading to fragmented neighbourhoods and communities. In an effort to explore new ways of providing for and accessing transport modes, policy and decision makers are considering new planning and delivery models. One model that has risen to prominence amongst transport professionals is Mobility as a Service (MaaS). Hailed as a new way of planning, operating, and accessing transport modes, MaaS is frequently noted as a new opportunity to offer more personalised, seamless, and reliable transport to urban and rural areas. In order to do this, a MaaS system would offer grouped transport to individuals, whether through a monthly subscription or a pay-as-you-go package, allowing access to a wider range of transport and offering travellers more opportunity to use public transport and active travel. Through a MaaS system, it is often assumed travellers would be more attracted to public transport and the system would reduce the reliance on private vehicles.

However, with no large-scale system in operation, many of the benefits of MaaS are based on assumptions and results of small-scale trials. As such, there are several gaps in knowledge around how MaaS could be implemented, including the roles of the public and private sectors, the business model and subsidy requirements, and the payment and ticketing system. With limited information to support the development of a system, cities looking to implement MaaS must either rely on parameters established in trials elsewhere or must develop their own in response to their challenges.

This research considered MaaS through the lens of a city region case study (Greater Manchester) experiencing many of the notable challenges that result from recent economic growth and an increase in transport use, particularly the use of private vehicles. Using a mixed methods approach, including in-depth interviews, policy analysis and quantitative analysis of transport patterns in Greater Manchester, this study considers how MaaS may contribute towards the reduction of some of the key transport challenges in the city region, and how it may fill gaps within the transport system.

Results detailed in this work highlight that there are several gaps in knowledge regarding the concept of MaaS, which require greater clarity in order for policy and decision makers to

proceed with designing and implementing a system suitable for specific areas. These gaps in knowledge include ongoing challenges within the concept of MaaS itself, including:

- A lack of clear definition;
- Differences in assumed benefits; and,
- Disbelief around how a system could be designed and implemented on a large-scale.

The results of this study contribute towards filling these gaps in knowledge, offering best practice from areas which have adopted innovative transport measures and new perspectives from transport professionals and experts on how a system could be designed and refined, tested, and implemented at scale. This thesis concludes by recommending potential routes forward for policy makers and areas for future research.

# 1. Chapter One: Introduction

The transportation sector, as with other industries, has evolved throughout history to meet the local, regional, national, and international requirements of individuals and organisations (Boyer & Durand, 2016; Exposito-Izquierdo et al., 2017; Silva & Tatam, 1996). In the case of many urban transport systems and infrastructure, networks have been designed to accommodate the private car at the expense of other forms of transport and, in some cases, the cohesiveness of urban communities (Audouin & Finger 2018; Theriault et al., 2020). The rise of private car use that followed created congestion, polluting emissions, and has had negative effects on physical and mental health.

A range of policies have been introduced in cities globally to try and control or cope with the increases in demand, particularly for travellers using private vehicles (Eriksson et al., 2006; Loukopoulos et al., 2004; Zhao et al., 2010). Numerous interventions have also been trialled to encourage behaviour change including, but not limited to, congestion charges, positive publicity associated with active travel modes, parking fee changes and free and discounted public transport tickets (Cairns et al., 2004; Jakobsson et al., 2002; Karlsson et al., 2016; Washbrook et al., 2006). Alongside this, during the 2020 COVID-19 pandemic, additional measures which supported modes that offered physical distancing from other individuals were actively promoted, including offering pop-up and permanent cycle lanes (Rerat et al., 2022; Tirachini & Cats, 2020).

However, in many areas private vehicle use is still prevalent (Garling et al. 2002). The reasons for this are related to characteristics and circumstances which vary by area, but generally include flexibility, assumed reliability, perceptions of safety, convenience and difficulty matching public transport services to complex lifestyle requirements (Araya et al., 2022; Le & Trinh, 2016; Witte et al., 2013; Zhou, 2012). Adding to these reasons, the recent COVID-19 pandemic reshaped urban and rural transport during and after regional and national lockdowns (Downey et al., 2022). Those who were unable to work from home during lockdown, but owned a private vehicle, turned increasingly to this mode as a means of transport that avoided sharing space with others (Downey et al., 2022). Following a 2021 Public Attitudes Survey, Transport Scotland (2021) noted that 34% of respondents stated they would continue to use their private vehicle in place of other modes following the lifting of lockdown. These concerns have added

a new challenge for policy makers to consider when looking to encourage the development of sustainable and healthy travel behaviours in urban and rural areas.

## 1.2New models of transport planning: Mobility as a Service

Mobility as a Service or "MaaS" is a term that has emerged and gained traction amongst transport planners, operators, automotive manufacturers, and technology developers, as a potential mechanism to reduce or remove the challenges currently faced by urban areas (Exposito-Izquierdo et al., 2017). Whilst there is a lack of clarity and consistency around the definition of MaaS, Exposito-Izquierdo et al. (2017, 412) argue that MaaS can be defined as:

> *"a sophisticated conglomerate of heterogeneous transportation means, physical infrastructures and information and communications technologies working in combination to enable citizens to reach their destinations efficiently".*

To offer a MaaS transport planning and delivery system, a range of seemingly independent systems must work together, including physical infrastructure and communications technologies (Exposito-Izquierdo et al., 2017). Alongside this, it is assumed that a broad range of transport modes would be offered to travellers, as highlighted by Brown et al. (2022, 302):

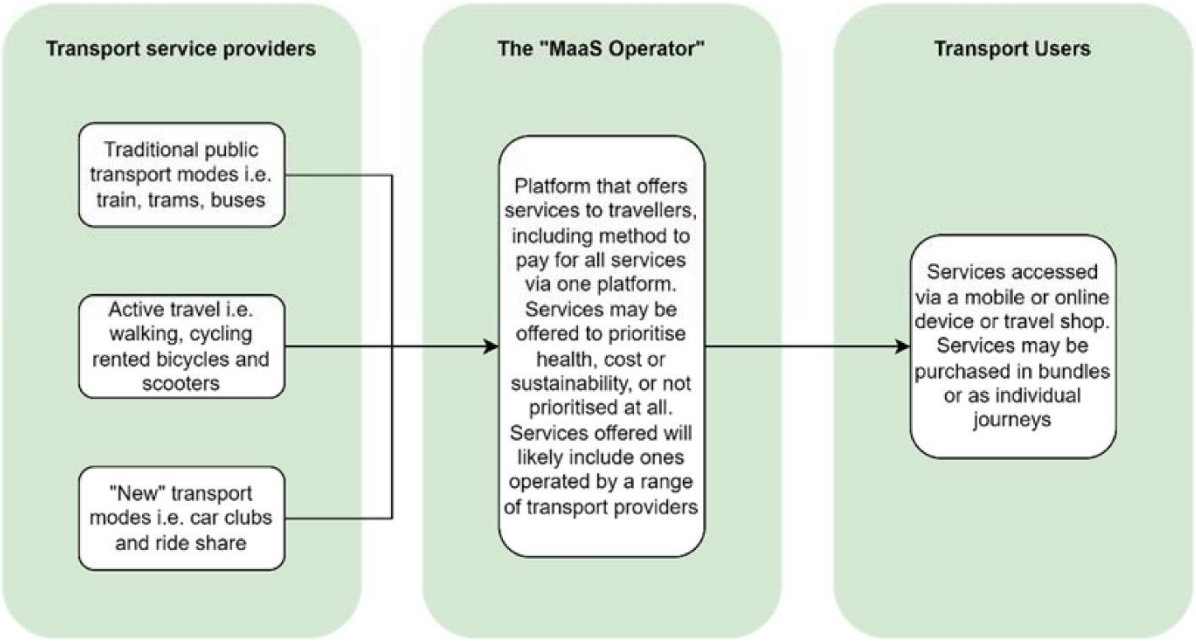



**Figure 1.2: An infographic highlighting transport services in a simplified MaaS system. Source: Brown, Hardman, Davies and Armitage (2022, 302)**

Several potential benefits are often mentioned in relation to MaaS, particularly outcomes that are perceived as benefits to the individual user, such as: personalised mobility; seamless and

interconnected travel; more on-demand services; and, and accessible transport (Mulley et al., 2018; Pangbourne et al., 2020). Hensher (2017) argues that MaaS, facilitated by new technologies, offers travellers access to a range of different transport services via a single user interface, including public transport and on-demand services, which in turn offers increased flexibility, choice, and convenience without needing to own a private vehicle. Interestingly, Pangbourne et al. (2020) note that the rhetoric surrounding the MaaS concept is being used in a way to enable people to visualise how a system could impact known issues and patterns that exist in cities, towns, and transport networks, but it is largely based on speculation.

It is not yet known how MaaS might impact a city, as no trials have been conducted at scale or for significant lengths of time, whilst only small trials in confined areas or for short periods have been conducted in a number of places to date (Quilty et al., 2022) . However, interest in the term and range of definitions is building, in part because of the assumptions made about the potential benefits of MaaS and the lobbying in favour of the concept being undertaken by a several organisations (Audouin & Finger, 2018). In response to this, cities and towns are attempting to develop MaaS policies, trials and programmes guided by other trials, availability of grant funding and concepts being developed by actors and organisations which may not have a nuanced view of the unique and complex challenges transport networks face moving forwards.

In light of this, this doctoral study will critically investigate how MaaS may be implemented, using the region of Greater Manchester in the UK as a study area, and to analyse the potential barriers to implementation in the study area.

## 1.1 Greater Manchester: a case study

This research focused on Greater Manchester as a regional case study. Made up of ten districts, the city regional is highlighted in figure 1.3.


**Figure 1.3: Greater Manchester map highlighting district boundaries. Source: Greater Manchester Combined Authority (2021, 36)**

Greater Manchester is currently experiencing rapid growth, with over 300,000 new residents and 600,000 new trips each day predicted across the conurbation, by 2040 (TfGM, 2017/2021). The Greater Manchester 2040 Transport Strategy recognises the lack of available space to increase capacity within the dense urban centre of Manchester City and how this conflicts with the projected rise in the number of daily trips in across the conurbation over the next 25 years (TfGM, 2017/2021). Alongside this, strict targets to reduce the negative effects transport emissions and congestion can have on physical and mental health, and a need to provide an increased number, and a wider variety, of transport services in line with changes in customer expectations, have led to a recognition that new methods in mobility provision and service delivery need to be explored.

With ambitious targets to create a green city and zero carbon city region by 2038, Greater Manchester has clearly set intentions for the short and long-term development in the city region (Greater Manchester Combined Authority, 2019). However, with a fragmented transport

system that is both confusing and inefficient (TfGM, 2017), transport will play a key role in whether or not the city region authorities can realise their goals.

Greater Manchester is not the only city or city region faced with this issue, and academic literature reflects this, particularly in relation to the emergence of new mobility concepts to combat congestion and mitigate the negative impacts of transport on physical and mental health (Exposito-Izquierdo et al., 2017; Schade et al., 2014). Greater Manchester has been selected as a case study as it allows for transferable insight. With other cities and city regions of similar size globally attempting to combat challenges of a similar nature, the insights gained in this research may offer some insight into opportunities to improve transport systems in support of reaching economic, social, and environmental goals. Furthermore, the city region model is being upscaled across the UK, with other areas following in Greater Manchester's footsteps; the findings of this research are potentially transferable to these other contexts.

## 1.2 Aim and research questions

The aim of this research is to critically investigate the potential impact of implementing a MaaS system, using Greater Manchester in the UK as a case study, to identify relevant policy application opportunities, examples of transport planning changes, and mechanisms to overcome barriers to the introduction of sustainable MaaS system. The use of the term "sustainable" in this study refers to an ongoing system which is not limited by the boundaries of a trial or funded project. The following questions were identified to fulfil the primary aim:

1. What are the key challenges and barriers to the development and implementation of a MaaS system?
2. What benefits may a MaaS system bring to cities or city regions?
3. What best practice, with regards to considering and implementing innovative transport measures, exists from cities worldwide?
4. What are the key transport challenges and gaps in Greater Manchester?
5. How could MaaS support the reduction or removal of transport gaps and challenges in Greater Manchester?

Whilst this research focused on Greater Manchester as a case study, the techniques and processes used are transferable to other urban and peri-urban areas. International policies were reviewed in reflection of this.

## 1.3 Thesis structure

This thesis is structured as follows: chapter two reviews existing literature on MaaS and associated topics, including transport and the urban realm; transport's impact on society; current issues associated with the negative externalities of transport; and, interventions intended to mitigate the negative impacts of transport on urban areas. The chapter identifies gaps in existing literature along with potential areas for future research. Chapter three details the methodological approach and the methods used. Chapter four provides a brief overview of MaaS. Chapter five follows by describing the case study area in detail, including the political structure, the local transport landscape and acceptance of innovation to date. Chapter six details the results of the in-depth interviews with experts and discusses the current thinking of MaaS at the professional level. Chapter seven gives insight into the transport and urban policies of the thirty most innovative cities globally, along with the Local Transport Plan and city region strategy of Greater Manchester. Chapter eight considers the current transport patterns in Greater Manchester, highlighting where the current transport system complements noted MaaS key components and where it differs. This chapter is followed by a discussion (chapter nine) of all the results chapters, which brings together the analyses of the results, asks questions of the current Greater Manchester transport network and of MaaS as a transport planning concept. Areas for further research are identified, along with proposed questions that remain unanswered. Finally, the thesis concludes in chapter ten by making recommendations relevant to local and transport authorities in Greater Manchester, along with recommendations for future research. Figure 1.4 highlights how the chapters link together to inform the final discussion and conclusion.

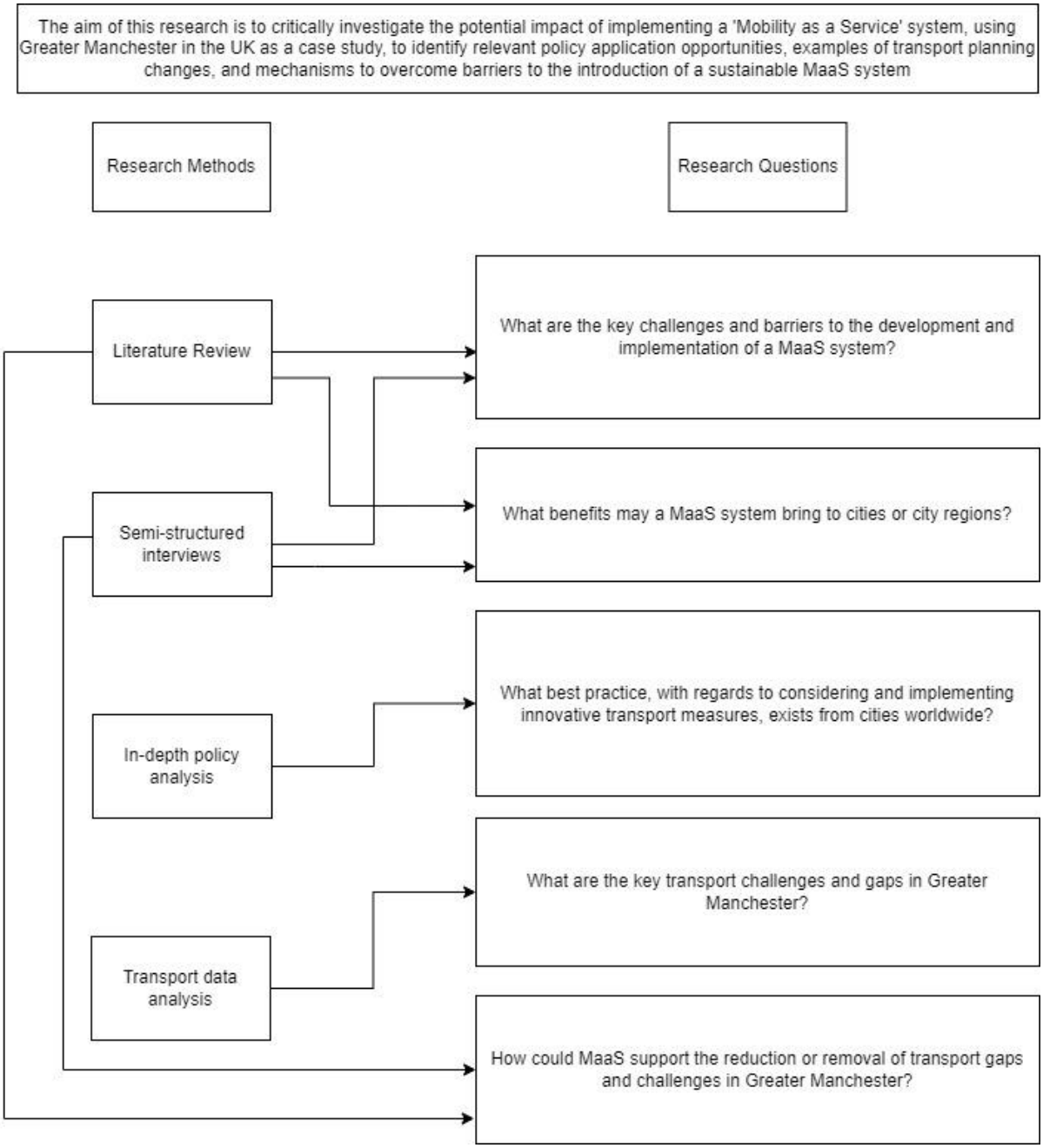



**Figure 1.4: Research questions and methods. Source: author**

# 2 Chapter Two: Literature Review

Having laid out the aim, research questions and the justification of the research in the previous chapter, this chapter reviews the current literature which frames current transport challenges and patterns, alongside MaaS. It begins with an overview of the role of transportation with a focus on urban areas. Literature was sourced from several places: Science Direct, Google Scholar, professional white papers and documents, and mass media publications. Keywords were initially used alongside a snowballing approach when information was found in publications that provided direction to further publications and information.

This chapter details the impact of transport on society and current transport trends, along with the impact current patterns of transport use are having on cities. Previous and ongoing interventions relating to transport are also discussed. This review then considers details of MaaS, from the perspective of existing literature, including the challenges and barriers to implementation and the assumed benefits. Finally, the chapter considers wider concepts relating to MaaS, including the sharing economy and shared mobility. The chapter concludes by summarising the gaps in research and possible areas for further investigation moving forwards, along with summarising the impact the Covid-19 pandemic has had on urban transport networks. This approach to the literature review was adopted in recognition of the long-term impact transport has had on societal development and economic growth, along with the challenges that have emerged due to policy and investment decision making with regards to transport service and infrastructure provision. These areas, and the context within which they place transport planning, are essential to understanding the potential role MaaS may play, how it has emerged and how it may develop in future.

As highlighted in the following sections, transport is a key factor in economic growth and quality of life, but the impact transport has on people and places goes beyond an individual moving from A to B as part of their daily life (Eißel & Chu, 2014). The use of transport generally has risen through the twentieth and twenty-first centuries, but with it so have some of the negative externalities such as emissions and noise pollution, infrastructure developments that prioritise certain vehicle types and fragmented ticketing and regulatory systems that can make accessing transport a complex task (Bagloee et al., 2016; Hensher & Puckett, 2007; Martinez & Viegas, 2017). It is also often argued that the development of the motor vehicle and its mass adoption has created new patterns of travel behaviour (Amos, 1972).

## 2.1 Transport and society

Starting on December 1st in 1913, the first assembly line for the mass production of motor cars was heralded as the turning age for individual mobility. In little over 100 years since 1913, there are now more than 1 billion cars estimated to be in use around the world and a concept was named after the new style of mechanised production: Fordism (Boyer & Durand, 2016; Navigant, 2017). Whilst the invention of the private vehicle and the use of new technologies in manufacturing has had a notable impact, transport has been used as a mechanism for growth for many years (Boyer & Durand, 2016; Silva & Tatam, 1996). Silva and Tatam (1996) argue that throughout history, from the Roman Empire's expansion across Europe using newly constructed roads to the Venetian accumulation of wealth using canal networks, transport has been the link that enabled growth to happen.

As a sector, transport is considered by many groups to have had a significant impact, both positive and negative, on society (Sdoukopoulos et al., 2019). However, transport is not wholly for the movement of people. Economic systems and prosperity have also relied on the ability to move goods at a pace that meets consumer demand (Sdoukopoulos et al., 2019). Alongside this, the growth that transport has enabled has ensured it is a major contributor to economies, with transport jobs accounting for over 5% of total employment in the European Union, and over 7% of European GDP (Eißel & Chu 2014).

Since 1950, the global urban population has increased from 751 million to 4.2 billion, and this growing population's transport needs now play a key role in society (Dan-Jumbo et al., 2018; Yang et al., 2019). Local, regional, and national authorities have invested in infrastructure that has prioritised transport modes that have been popular in order to meet consumer demand. An example can be seen with the UK, in which 77% of its households own at least one vehicle (Department for Transport, 2019), with the private car receiving significant prioritisation in infrastructure spending (Silva & Tatam, 1996). This has resulted in many benefits to private vehicle owners, to the point where both urban and rural areas may suffer fragmentation and isolation from other communities due to the layout and abundance of highways infrastructure (Broniewicz & Ogrodnik, 2020).

The increase in infrastructure provision, the introduction of the private vehicle, increasing income, and greater access to other modes in some areas, has meant that more people have chosen to live further away from cities or areas of employment, from educational facilities and from centres of leisure (Theriault et al., 2020; Ullmann, 1954). Theriault et al. (2020,2) argue that creating a "high mobility, high-living-standard society with free time" has meant that the

environment in which people choose to reside has changed, resulting in the development of sprawling, scattered residential areas. However, distributed populations and urban sprawl have emerged alongside income inequality and a stagnation in upward mobility, resulting in the geographical segmentation of society by socio-economic status (Ewing et al., 2016). Whilst this trend is not new, the problem has increased throughout the 20th century, impacting urban economic growth and urban planning (Ewing et al., 2016). As an example, in 1940 a higher percentage of urban based jobs in America were close to the city centres, but in 1996, only 16 percent of jobs were within 3 miles of the central business district in the average American metropolitan area (Kahn, 2001). Whilst it originated in the United States, urban sprawl now impacts many countries in the Global North (Lisowski et al., 2014; Moroni & Minola, 2019). Although there is an ongoing debate into the impact of urban sprawl, the private vehicle has been noted as a facilitator in urban sprawl growth (Lee, 2020).

With the growth of outer urban areas such as suburbs, a term used here to mean the decentralisation of people and housing, resulting in low density housing outside the core urban area, this has resulted in new expectations of access to equitable transport provision for sustainable modes, including public transport, which has become a challenge for local and regional authorities (Caggiani et al., 2020; David & Kilani, 2022; Gossling, 2016; Gunn et al., 2020; Lisowski et al., 2014; Pourtaherian & Jaeger, 2022). The distributed populations outside cities have made commercial operations of public transport services away from key corridors increasingly unlikely, resulting in unmet mobility needs and a reliance on private vehicle use (Gossling, 2016).

Defined by Ryan and Wretstrand (2019, p. 107) as the "mobility needs that remain unfulfilled due to the inability to accomplish needed or desired journeys and activities", unmet need will present another challenge to those planning a transport system which focuses more heavily on sustainable mode choices. In this sense, the ability to provide sufficient transport opportunities to meet the population's need may include services which are not able to operate commercially and therefore require public subsidy. Harper, Hendrickson, Mangones and Samaras (2016) and Levy (2016) note that the elderly, young, women and people with medical conditions are disproportionality affected when there is low accessibility to transport.

To meet consumer demand, access to shopping facilities has also changed. Large, out of town shopping centres and malls, with ample areas for parking, have been placed along key motorway routes at a distance from city and towns, both in the UK and across the Global North.

Alongside out of town shopping facilities, the rise of online shopping has changed consumer habits further, by offering an easy and convenient method of consumption (Frick & Matthies, 2020). With goods available for low cost and with next day delivery, online shopping brands are using transport infrastructure, including the highways infrastructure, to move goods around the country at an increased pace. The rise of goods transported via road has meant an increase in logistics vehicles, with van traffic increasing in the UK by around a fifth in the last ten years (Cherrett et al., 2017). The rise in shipping due to an increase in trade internationally, has meant a larger range of goods can be purchased online and delivered to consumers without them leaving home (Pleninger & Sturm, 2020).

The changes in land use planning, city and town layouts, and the ability to purchase goods, has had a significant impact on society, and many of these changes were facilitated by transport. Lyons (2004) argues that to date transport has shaped society as much as society has shaped it. This continues to be the case with new emissions related targets, set out by the government in 2019, to reduce the UK's net emissions by 100% (relative to 1990 levels) by 2050 (Institute for Government, 2021). These new targets will have to incorporate changes to transport modes and services used in the United Kingdom, but it is unclear how these changes will be incorporated and implemented into transport strategies and operational planning.

## 2.2 Transport and the urban realm

In 1899, Adna Weber argued that the concentration of people in cities is one of the most notable phenomena in social history. Weber (1899) went on to argue that cities mark the level of progress society has made in intelligence, arts, social enjoyment, and mental activity. Alongside this, Park (1915) argued that whilst city plans aim to establish boundaries and rules to urban growth, human nature frequently provides the character which gives areas notable features; a mechanism which is much harder to control. In recent years, the competitiveness of cities globally has resulted in high-quality, well-developed urban spaces (Anciaes & Jones, 2020). However, it has been recognised for some time that transport plays a key role in shaping urban design and development (Knowles, 2006; Knowles et al., 2020).

The prioritisation of cars in urban space design is described by Attard (2020) as an injustice constructed within urban areas themselves. "Saturation of the land" is a term used by Chiara and Pellicelli (2016, 1283) to describe the abundance of infrastructure constructed and the number of vehicles using the infrastructure in a specific area. Similarly, Attard (2020, 355) argues that having a transport system geared towards the private car impacts the "right of access" for non-car owners attempting to undertake journeys. Alongside this, the property

pressures of a society increase in line with infrastructure spending including considerations of maintenance and maintaining functionality throughout the entire lifetime of an infrastructure investment (Chiara & Pellicelli, 2016).

In recent years, concepts of liveability and placemaking have entered discussions on transport, with policy goals being centred on creating an urban realm that is functional but which also promotes happiness (Anciaes & Jones, 2020). This in turn leads to investment considerations beyond the economic impact of a choice, which had largely been the guiding principle in previous years. However, the ability to value sustainable transport modes is critical for any shift in infrastructure spending and service provision to be effective (Anciaes & Jones, 2020). Anciaes and Jones (2020) argue that this must include indicators to judge whether or not an intervention is a success. With transport appraisal techniques predominantly favouring highway schemes due to the volume of car users, the tools public authorities possess to accurately assess the real costs and benefits of an intervention are not reflective of policy and placemaking goals (Anciaes & Jones, 2020; Laird & Venables, 2017).

However, old and new methods of urban planning that reflect changes in user needs (and expectations of liveable urban areas) have started to gain traction amongst professionals in transport and urban planning. Initially, Transit Orientated Development (TOD) was hailed as the leading transport and urban planning strategy to ensure residents and visitors of an area have access to public transport (Liu et al., 2020). Alongside this, concepts such as health cities and the 15-minute city have emerged as well (Wang et al., 2023).

## 2.3 The growing importance of sustainable mobility

Transportation predominantly enables access to education, employment, leisure, and social activities (Bagloee, et al., 2016; Martinez & Viegas, 2017), but can also reduce exclusion and broaden economic opportunities by connecting urban and rural areas, and other marginalised areas. Until recently, transport planners and urban architects in cities around the world were not asked to provide alternatives or reasons, but merely to meet the growing demand for mobility that society craved (Chiara & Pellicelli, 2016; Lyons, 2004). The structure and components of a transport system differ significantly depending on the location, population density and historical and cultural preferences of the area. The use of transport for employment, education or leisure purposes, has risen significantly through the twentieth and twenty first centuries (Hensher & Puckett, 2007; Leao & Elkadi, 2012; Lyons, 2016; Meyer, 1999; Stevens, 2017; Qiu & Yun, 2016; Zhao et al., 2010).

Over time, partly due to the significant increase in urban populations the 20th and 21st centuries, transport systems face a growing number and range of pressures (United Nations, 2018). These pressures, and the attempts to reduce or remove them to date, have highlighted that innovative solutions are required to improve overall efficiency and cater for the increasing demands (Karmargianni et al., 2015). It is projected that over 65% of the global population will live in urban areas by 2050 (United Nations, 2018). Currently, over 60% of all travel is undertaken within areas that are considered urban, but this number is expected to triple by 2050 (Van Audenhove et al., 2014). With this in mind, how transport is planned, operated and accessed will have a significant impact on urban planning, access to employment and education, public health and mobility accessibility (Diao, in press; Hu et al., 2016). Whilst planners may previously have looked to out of town employment and shopping facilities, now transport and urban planners are looking to bring home and key travel locations closer together, with the intention of making sustainable transport modes a more attractive option (Guan & Wang, 2019). The ability to optimise the use of existing infrastructure is noted by Sdoukopoulos, Pitsiava-Latinopoulou, Basbas & Papaioannou (2019) as central to implementing sustainable policies. In place of increasing the amount or coverage of infrastructure, Sdoukopoulos et al. (2019) argue that mobility management tools and strategies will offer long-term and holistic solutions to transport systems in future.

The possibility of a paradigm shift relating to transport planning and provision in urban areas is gaining interest and momentum (Mozos-Blanco et al., 2018). Expectations from individuals on what transport should deliver has changed over the years, but governments are now considering ways in which to reduce or restrain use of private cars in an effort to improve urban spaces and reduce health disbenefits of excess motor vehicles (Anciaes & Jones, 2020). The purpose of controlling car use, Anciaes and Jones (2020) argue is to improve both conditions for non-car users and to improve the urban realm as a space for individuals to be in. However, the ability to increase public transport ridership relies on a number of factors, with provision alone potentially not being enough to encourage uptake. Vicente et al. (2020) argue that there is a perception of public transport, which includes how people see public transport as contributing to both their own welfare and potentially to that of wider society as well.

## 2.4 Current trends

Holz-Rau and Scheiner (2019) argue that increases in private car use and freight transport have happened consistently since the Second World War. The UK's Department for Transport (2019) Transport Statistics report states that over 80% of passenger kilometres in 2017 were travelled by car, van, or taxi. Alongside this, whilst 4.9 billion passenger journeys in the UK were taken by bus in 2018, this number is 8% less than 2015 showing a decrease in the volume of users (Department for Transport, 2019). Alongside this, figure 2.1 highlights another UK example, showing that whilst the overall number of trips has reduced since the early 2000s, the length of trip and time spent travelling has increased (Department for Transport, 2018).

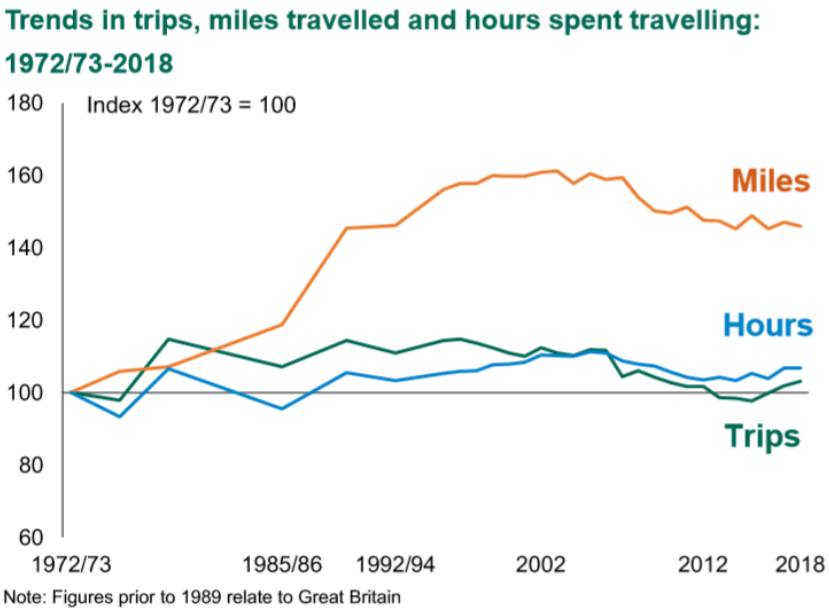



**Figure 2.1: trends in UK trips conducted between 1972 and 2018. Source: Department for Transport (2019, 1)**

The 2020 COVID-19 pandemic added to these issues, with public transport user numbers collapsing in many area, including New York City (number of users decreased by 97%) and across Australia, where the number of public transport users decreased by almost 80% (Beck et al., 2021). Eisenmann et al. (2021) made similar observations, going on to argue that the uptake in private vehicle use, combined with long-term concerns around the bio-security risks of using public transport, has led to new behaviour pattens forming which will be hard to change moving forwards.

Noting the increasing reliance on private vehicles, alongside significant growth in urban resident numbers, Audouin and Finger (2018) argue that the key issues associated with transport today stem from the fact that urban transport systems have been designed to

accommodate the private car at the expense of other forms of transport and urban residents. Alongside this, they also argue that culturally, a privately-owned vehicle has become embedded in many societies and is no longer considered as just a mode of transport.

With countries around the world experiencing increasing trends of congestion, polluting emissions, transport related mental and physical health problems, and increasing demands for access to transport, mobility in urban areas has reached a critical point and current transport trends relating to private car-based transport are no longer sustainable (Debnath et al. 2014; Epprecht et al., 2014; Jones, 2014; Karlsson et al., 2016; Utriainen & Pollanen, 2018). However, everyday decision making on modal choice by passengers is often guided by a range of factors, including ones that are out of direct control of the person travelling. These factors can include convenience, reliability, flexibility, financial constraints, physical accessibility (proximity or ability to physically access a mode) or the need to interchange, and many of these factors are intrinsically linked (Glaister & Graham, 2006; Hensher et al., 2013). The following sections detail some of the key issues and challenges facing urban transport planning and provision.

### 2.4.1 Transport related pollution

A number of transport externalities have negative impacts on society, affecting users and non-users of both public transport and private vehicles alike , but poor air quality linked to vehicle emissions is one of the most severe, impacting human health and climate change (Attard, 2020; Eißel & Chu, 2014; Giannouli et al., 2011; Li et al., 2019; Walker & Marchau, 2017). Spector et al. (2020, 1) argue that transport is one of the "most expedient means by which humankind affects Earth's ecosystem". Whilst not limited to emissions, this statement highlights the significance of the impact transport choices have on the wider environment.

Polluting emissions from transport impact on physical and mental health, and climate change, and are a key contributor to deteriorating health and fatalities experienced each year in a wide range of countries (Behzad et al., 2013; Rowden et al., 2011). The World Health Organisation (2021) estimates over 4.2 million premature deaths globally were attributable to outdoor air pollution in 2016, with transport contributing between 12%-70% of emissions depending on the total pollution mix. In the UK, poor air quality is the largest environmental risk to public health with low-income communities more likely to be affected (Public Health England, 2018).

However, air pollution is complicated, particularly with regards to urban transport. The Department for Environment, Food and Rural Affairs (2019) publishes statistical data that

analyses emissions levels that negatively impact human health and ecosystems in the UK and covers sulphur dioxide ($SO_2$), nitrogen oxides ($NO_x$), non-methane volatile organic compounds (NMVOCs), ammonia ($NH_3$); and particulate matter ($PM_{10}$ and $PM_{2.5}$). Of these pollutants, $NO_x$ and $PM_{10}$ and $PM_{2.5}$ are attributable to transport and significant proportions are created during fuel combustion and use of brakes or tyres. However, alongside these pollutants, carbon dioxide ($CO_2$) is also significant contributor to climate change and a partial contributor to poor physical health. Carbon dioxide is generally most frequently referenced in academic publications, industry documents and media articles, and public policy makers have taken a great interest in interventions to mitigate emissions (Zhang et al., 2018). Similarly, sustainable infrastructure policies and land use planning have considered polluting emissions for some time, with Zhang et al. (2018) stating that land use planning may be able to achieve reductions in transport related carbon emissions.

Eißel and Chu (2014) state that since 2007, the European Union has adopted three key principles that support a reduction in carbon dioxide emissions:

1. Optimising transport demand and provision;
2. Reaching a more sustainable modal split, including a higher utilisation of public and non-private car-based modes; and,
3. Utilising new vehicle technologies to improve emissions for every journey made.

Following the establishment of these principles, countries within the European Union have also committed themselves to goals to reduce Greenhouse Gas emissions, improve energy efficiency and increase the amount of energy produced from renewable energy sources (European Parliament, no date). However, Lucas and Jones (2012) and Clora and Yu (2022) argue that the actual application of measures to reduce pollution face slow implementation approaches and often still focus on economic growth as a key indicator for intervention.

Achieving low-carbon urban transport systems is a key element in creating low-carbon cities, however the ongoing reliance on using a private vehicle has hindered many efforts to date. The attachment to private cars is now increasingly understood to be based not only on transport needs, but also reflects trends in consumer culture, with private vehicles noted as representing societal ideals such as affluence and freedom (Bartikowski & Cleveland, 2017). Whilst transport emission related pollution is a severe consequence of urban economic growth and the ownership of private vehicles, it is closely linked with a number of other issues in urban areas that have been difficult to mitigate or solve (Lucas & jones, 2012).

### 2.4.2 Congestion in urban areas

Congestion occurs prominently in areas with high levels of car ownership (Levy et al., 2010; Metz, 2018), and stems from the inability of road capacity, and wider urban infrastructure, to meet the demand for trips that are required at certain points in time; this is more notably during the morning and evening commuting times. The costs of congestion are typically: economic, time and physical and mental health (Dixit et al., 2022; Kim, 2019; Struyf et al., 2022). However, traffic congestion has become the norm in many urban areas as residents have sprawled out into suburbs but maintain a level of expectation related to accessing employment and education in urban centres (Li & Liu, 2017).

In the United States, commuters spend an extra 54 hours a year in traffic delays on average in comparison to hours spent in free-flowing traffic (Bopp et al., 2018; Schrank et al., 2019). The costs associated with this are then passed on as an economic burden, predominantly impacting productivity and delays to the consumer. The IBM Commuter Pain Survey (2011) found that in many cities surveyed, the respondents claimed traffic problems were increasing and this was negatively affecting personal stress, anger and their employment or educational performance.

Advanced technology and better use of technical systems has presented an opportunity in urban areas, namely, allowing efficient networks to emerge that can positively utilise new innovations and create a newer, resource-light economy, while maintaining and expanding access to transport products and services (O'Rourke and Lollo, 2015). Smith et al. (2018) argue that changing economic circumstances and attitudes towards transportation modes are already having an impact on how people travel. Alongside this, Smith et al. (2018) argue that disruptions in the transport sector from new operators utilising innovative technologies to improve customer access and experience is changing the transport sector as well. Similarly, some of the newer concepts of transport and urban planning mentioned in section 2.1 relate to an increase of technology use as well, notably the smart city concept (Lai & Cole, 2022).

In response to congestion, some urban areas have adopted the approach of adding more capacity for vehicles to operate, believing this would alleviate the problem (Metz, 2018). Areas such as Los Angeles, have become synonymous with severe congestion issues that have only increased as additional highway capacity was constructed (Mougeot & Schwartz, 2018). However, creating more roads that cut through communities and allow more vehicles to operate has increased the negative impacts of private vehicle use in urban areas (Metz, 2018). In an attempt to tackle congestion, some urban areas have introduced road user charging (Metz, 2018; Vanoutrive & Zijlstra, 2018). Research has been conducted on the impact of road user

charging in a number of cities, but there appears to be little consensus among academics as to whether road user charging has a positive impact. Metz (2018) states that there is little evidence in the case of London, Stockholm, and Singapore to support the use of congestion charging as a mechanism to combat congestion. The 2018 article argues that many congestion charge systems do not go far enough in their scale and/or enforcement to sufficiently deter car drivers. Munford (2017) suggests there is ample evidence to support the use of road user charging as a mechanism to combat congestion, but their study does identify a negative potential outcome following an examination of the impact of road user charging on an individual's social capital and willingness to invest in activities that would contribute towards the growth of social capital overall. In contrast to Metz (2018) and Munford (2017), Zhang and Shing (2006) go as far to state that road user charging has negative knock-on impacts on the wider economy, with a reduction in house prices seen inside the London Congestion Charge zone which they attribute to the use of a congestion charge.

### 2.4.3 Accessibility

Gossling (2016, p.2) argues that for many years "numerous authors have emphasised that cities are not equal", noting that transport accessibility is part of the conflict in land use and transport equity. The ability of cities to act as tools for inclusive development is often impacted by urban and transport planning choices, with equitable access to services a key determinant in whether a city's development has been "inclusive" (Boulange et al., 2017).

The ability to access services, employment, education, and other people is the core purpose of transport. Alongside this, mobility is a key requirement for ensuring regions and residents are socially included (Stanley et al., 2019). The better the access, the better the benefits for the residents, visitors, and workers of the urban area (Rode & Cruz, 2018). Defined by Caggiani et al. (2019, p.60) as "the extent to which land-use and transport systems enable individuals (or groups of people) to reach activities/opportunities in the network (workplaces, shops, public transport station and stops, health facilities, etc.) using a (combination of) transport mode(s)", how transport is accessed, including whether there is adequate provision, if the provision is affordable and the means in which to access the provision of transport are available, impacts well-being, quality of life and physical and mental health. A significant body of literature exists on transport accessibility and the impact it has on people (Cervero 2001; Chi, 2012; Houghton 1995; Knoflacher et al., 2008; Simpson 2004). However, from a transport planning perspective, accessibility is about managing the links between systems and goes beyond individual modes or single routes (Rode & Cruz, 2018). Alongside this, Caggiani et al. (2019) argue that in order

to have equitable transport, accessibility must be considered in the fair distribution of costs and benefits across the society in which the transport system is available.

Bills and Walker (2017) argue that accessibility issues in transport are particularly relevant when considering societal inequalities. These issues have emerged due to unfair consideration of the needs of advantaged members of society, with existing conditions impacting disadvantaged members of society (Bills & Walker, 2017). Accessibility plays a key role in transport planning and policy development; however it is a concept that is often poorly understood, miss-represented or poorly defined during transport planning processes (Bills & Walker, 2017; Geurs & Wee, 2004).

Dempsey, Brown, and Bramley (2012) argue that sustainable communities are maintained by ensuring a fair distribution of resources and participation of social groups in social interactions within local communities. Similarly, Antonson and Levin (2020) argue that mobility providers and planners are now considering the linkages between transport and land use, noting the issues some citizens face with both in their daily lives. In recent years, the term "Smart Growth" has emerged amongst transport planners, policy makers and academics when considering sustainable and equitable transport interventions (Appleyard et al., 2019). Defined as a theory that aims to facilitate growth of compact urban centres that are walkable, transit-orientated and include mixed-use developments (and particularly prevalent in the United States), Smart Growth aims to offer equitable access to transport for all but in the context of climate change, population growth and reducing infrastructure budgets (Sciara, 2020). Similarly, smart mobility aims to use new technologies (predominantly networked communications such as the Internet of Things, but also new modes and service models) to improve the provision and operations of transport services (Porru et al., 2020). However, these terms are frequently applied to improving mobility and land use planning but not necessarily accessibility (Ferreira & Papa, 2020).

In contrast, the *accessibility approach* considers both access to improved mobility options or conditions, and also reducing the distance between organisations and the locations of people that need to use them (Ferreira & Papa, 2020). When paired with considerations of transport justice, studies have shown that public transport spending and investment has often reflected the needs of the few instead of the needs of the many (Vanourtive & Cooper, 2019). Vanourtive and Cooper (2019) highlight the case of the Californian Metropolitan Transportation Authority: whilst 94 percent of ridership was on buses, the Transportation Authority focused 71 percent

of public spending on rail initiatives that benefited less than 6 percent of travellers (the majority of which were white). Current literature highlights that whilst new theories on smart or improved planning processes exist, infrastructure and service expenditure does not yet reflect the intentions of these theories (Fainstein, 2010; Gossling, 2016).

## 2.5 The art of the intervention

Tidball and Stedman (2013) state that modern humans are no longer able to view themselves as ecological beings which are part of the natural world, and therefore are unable to appreciate the scale of impact humans have on environments, which requires consideration and accountability, particularly through resource consumption in an urban context. This correlates with the fact that whilst people are aware of the negative impact private vehicles have on themselves, the environment, and others, they are often hesitant to give them up even when offered alternative choices that are more effective in lowering environmental impact in the long-term (Stradling et al., 2000; Rahman & Sciara, 2022).

In an attempt to try and control or cope with the increases in demand, particularly for travellers using private vehicles, policies have been introduced at regional and national levels (Eriksson et al., 2006; Loukopoulos et al., 2004; Zhao et al., 2010). However, in some areas private vehicle use is still prevalent (Garling et al., 2002; Le & Trinh, 2016; Pojani et al., 2018). The reasons for this vary by area, but generally include flexibility, reliability, convenience, the car being recognised as a cultural symbol of status (in contrast to the bicycle) and difficulty matching public transport services to complex lifestyle requirements (Le & Trinh, 2016; Witte et al., 2013; Pojani et al., 2018; Zhou, 2012). As highlighted earlier, this practice has increased during and post-COVID, with private vehicle use increasing due to altered working patterns, heightened health concerns and other reasons, as noted in chapter one (Rerat et al., 2022; Tirachini & Cats, 2020).

Witte et al. (2013) argue that mobility choices, particularly for those who use a private vehicle, are accompanied by negative side-effects, and awareness of these side effects and the impact they have on both the user and non-users is growing. The rise of driving has been coupled with a rise in obesity, poor mental health, higher stress levels and lack of exercise leading to poor physical health (Ding et al., 2014). The influence of transport emissions on health is a particular concern (Qiu & Yun, 2016). Qiu and Yun (2016) state that particulate matter alone contributed to over 1 million premature deaths in China in 2010. However, researchers have been discussing the impact of transport emissions on health for many years: Jephcote and Chen (1982) theorised that the quantity and range of pollutants emitted from vehicles in close

proximity to residential areas is an environmental injustice for those whose health is affected. The impact of this research on public policy, to influence the use of transport modes and mitigate the health impacts, has been slow to date, with transport interventions instead focusing on exploiting and maximising economic opportunity (Jones & Lucas, 2012). However, Exposito-Izquierdo et al. (2017) state that an increasing number of organisations and actors globally are calling for reform in how transport is managed, financed, and deployed, with a specific call for more sustainable options.

Alongside health impacts, Salon et al. (1999, 6) note that other downsides include: "increasing oil imports, ecosystem fragmentation and damage, and less access to goods, services and jobs for those without cars." Alongside this, Salon et al. (1999) note that there are a range of negative indirect externalities of car usage, such as unpleasant aesthetics. This highlights an ongoing argument that whilst electric vehicles are becoming more mainstream and will reduce some of the transport emissions (but not particulates, or manufacturing and maintenance emissions), an alternative to private cars is required to offer significant positive benefits (Exposito-Izquierdo et al., 2017).

Jaeger-Erben et al. (2015) theorise that everyday consumption, including mobility, is comprised of habits and routines which are rarely altered, or even considered outside of a major shift in pattern, for example changes in job roles, education and other reasons; this is in part due to them being embedded in social practices and material concepts. Many citizens prefer the stable functionality of patterns created through everyday routine, and as such, a significant shift or improvement in how services are offered is required to affect change on a large scale (Jaeger-Erben et al., 2015; Zhou, 2012). This complies with theoretical concepts which state that both conscious and subconscious actions are a result of cultural surroundings and are continuously re-created by individuals and therefore re-legitimised by existing structures. It also complies with theoretical concepts that argue that individuals utilise a cost-benefit analysis approach when making decisions, and familiarity and stable patterns will be considered as a factor during the decision-making process (Zhou, 2012).

Interventions that enable and encourage the uptake of sustainable modes have become an active consideration in policy making at city, national and international levels, and in academic research (Gabrielli et al., 2014). These interventions have included involving health services and community groups to highlight travel choices alongside potential health benefits such as GM Moving (2017), which aims to encourage uptake of physical activity and sport in Greater

Manchester. Significant changes have at times been caused by technological advancements, such as the private vehicle, and policies which either support or attempt to regulate activities have traditionally followed such revolutions (Jones, 2014). However, Audouin and Finger (2018) argue that the only way to instigate a sustainable and long-term shift from private car use is to offer a service that directly replicates the benefits of a car, whilst also offering additional benefits such as lower overall costs.

Jones (2014) argues that urban mobility mechanisms rely on a number of complex patterns and considerations, with customers, the market and public policy playing very different roles. Due to this, the user in a transport system is often unaware of the full cost of their choices or the impact their choices may have on the wider transport network. Holtz (2014) states, there are many models of customer behaviour and theories that are associated with each; however, few take into account the preferences, habits, and by extension, behaviours, consumers develop in a social context and are therefore unable to account for behavioural change.

Efforts to manage increases in vehicle travel have been largely ineffective (Salon et al., 1999; Yang et al., 2022). Salon et al. (1999, 3), theorise that the challenge for cities is to reduce the negative impacts of personal transportation choices, while "retaining (or expanding) the mobility and accessibility benefits provided by cars". However, whilst there is a range of research on what could be best placed to achieve this, there is a lack of agreement across researchers on what solution would be suitable, sustainable, and also, potentially commercially viable.

To effect long-term change, any intervention must address the conditions in which sustainable travel can prevail including new infrastructure and the use of innovative technologies, alongside changing travel behaviours (Karlsson et al., 2016). Utriainen and Pollanen (2018) state sustainable transport solutions should form the basis of transport networks moving forward, claiming that daily trips should be made feasible by offering a range of integrated options that meet a user's needs.

Several transport planning interventions, typically a mixture of hard and soft measures, have been trialled to encourage behaviour change, including (but not limited to) congestion charges, positive publicity associated with active travel modes, parking fee changes and free and discounted public transport tickets (Cairns et al., 2004; Jakobsson et al., 2002; Karlsson et al., 2016; Washbrook et al., 2006). Alongside this, urban planning interventions including segregated cycle lanes (Hong et al., 2019), 'Travel Demand Management' (TDM) techniques

that prioritise sustainable modes in transport network operations (Batur & Koç, 2017), bus priority corridors (Seman et al., 2020) and smart ticketing to create an integrated approach to ticketing and pricing (Kumar et al., 2020). Structural changes are raised by Karlsson et al. (2016) as a mechanism to increase the quantity and quality of transport options that offer an alternative to the private vehicle for users. Alongside this, new concepts in transport planning and service delivery are starting to take advantage of technological advancements, offering a wider range of transport options to travellers (Puschmann and Rainer, 2016).

With regards to the success of measures to lower the use of private vehicles, an example of positive change is the City of London. Following the collection of long-term data taken from twelve sites across the City since 1999, data shows hat the use of motor vehicles has decreased by 64% whilst the volume of cyclists moving through the area has increased by 386% (Court of Common Council, 2023). It is worth noting that since 1999, the City of London has implemented several major changes that impact transport use and access. Since this time, the City has built segregated cycling infrastructure, it has been included in the congestion charge zone, public transport infrastructure has expanded including via the new Elizabeth Line and investment has been placed in positive publicity regarding the benefits of the use of cycling. This combination of measures has resulted in a positive shift. However, it should be noted that it is challenging to identify which measure had the largest impact with regards to shifting behaviour.

Often thought of as an efficient fixer for transport issues, Information Communication Technologies (ICTs), digital planning and ticketing platforms and digital booking systems for new transport operators have had a significant impact on the transportation landscape. However, instead of shifting travellers from relying on privately owned vehicles, these innovations have largely fragmented the transport system for users and created additional confusion (Audouin & Finger, 2018).

## 2.6 Shared mobility and the Sharing Economy

Sharing, as a concept, is not new (Acquier et al., 2017; Belk, 2010). Cohen and Kietzmann (2014) argue that in some forms, sharing options have always been available and publicly acceptable, such as shared property ownership. McLaren and Agyeman (2015) argue that cities are the original sharing platform. However, the Sharing Economy is a term that has recently exploded into the public discourse.

The sharing economy, which utilises these emerging technologies and enablers, particularly in information and communication and through mobile technologies, allows the market to interact with customers in ways that has not been previously possible, opening up new service opportunities for citizens to access (Le Vine & Polak, 2015). Hofmann et al. (2019, 1) define the sharing economy as:

> *"a new form of economic exchange that promotes the consumption of goods and services based on the principles of resource sharing, temporary ownership and access to digital platforms".*

However, whilst there is agreement that the Sharing Economy is a general umbrella term, it has been noted that agreement on defining the concept more specifically and the operational boundaries is still missing; this is particularly for those that would indicate success the success of the concept (Acquier et al., 2017). The term has been used by academics for some years and crosses over a number of other terms, including collaborative consumption, co-creation, accessed based consumption and consumer participation (Belk, 2014; Botsman & Rogers, 2011; Hossain, 2020). Currently, in most cases individuals purchase assets, the assets are typically utilised at time of need and then site idle at other times. This forms the basis of the existing ownership style model of purchasing and retaining something for individual use, with no intention of sharing it beyond friendship circles or immediate family groups, and particularly not to generate revenue.

Historically, the Sharing Economy has been linked to community driven enterprises, open-source licensing, and an economy that "benefits everyone" (Hossain, 2020; Martin, 2016; Morozov, 2013). However, in recent years it has become associated with global brands, confusion over employee rights, trade union disputes and Silicon Valley greed (Morozov, 2013). Emerging as a publicly recognised concept due to Uber and Airbnb, the use of platform models for Sharing Economy style brands has radically altered people's perception of accessing and using goods and services (Hossain, 2020; Martin, 2016). Alongside, Uber and Airbnb, brands such as Netflix and Amazon Prime have capitalised on viewers requiring access to new and different content without wanting to continually own what they watch. Economists speculate that the Sharing Economy could be worth in excess of $600m by 2027 (MarketWatch, 2022).

Hellwig et al. (2015) argue that not all those who engage in the Sharing Economy are the same and that whilst most may feel comfortable engaging in a business transaction through a noted

brand (i.e. Uber on behalf of private hire vehicles), fewer may be comfortable engaging directly in peer to peer sharing with their personal assets (particularly those with large value or emotional value). In relation to transport systems, Becker et al. (2020, 228) argue that "short-term travel behaviour is to a large extent governed by long-term choices of mobility tool ownership". This highlights that for non-public transport related modes (particularly driving and cycling), mobility still follows the traditional ownership model for assets. Similarly to others owned in the same way, these assets conform to the problem of sitting idle as well. As an example: the typical private vehicle in Europe and America is used less than 10% of the time (Sacks, 2011). However, whilst private vehicles (and by extension, transport more generally) make for easy examples of where the Sharing Economy could be applied, in a recent literature review using the terms "collaborative consumption", "sharing economy" and "collaborative economy", Hossain (2020) found only 9 articles in Transport focused journals, highlighting a gap in academic publications on the subject.

In terms of shared mobility, informal on-demand shared services have been utilised around the world for some time, particularly in countries in the Global South (Bajpai, 2016). Vine et al. (2014) argue that shared mobility systems are now transitioning from a relatively niche market into an urban mobility option that policy makers are seriously considering as a solution to urban mobility challenges. This is particularly true in the case of bicycle sharing programmes, which have recently been implemented in a number of major global cities (Sherriff et al., 2018). However, there is a lack of clarification around the term "shared mobility" in academic research, and therefore what researchers define as being and not being a shared service can vary considerably (Spinney & Lin, 2018).

Laporte et al. (2015) and Vine et al. (2014) highlight that traditionally, shared mobility has been considered a niche market that is unavailable to most people. However, due to recent technological development, shared mobility is now being looked at as a practical option for improving urban mobility and urban living (Midgley, 2011; Shaheen & Cohen, 2007; Vine et al., 2014). For the purpose of this literature review, shared transport services can include both centralised and decentralised services, planned and dynamic services, short and long journeys, and active travel services.

Research to date has highlighted that, for those who use them, shared services influence when, how and how often people travel (Vine et al., 2014). For example, Zipcar (2010) conducted a North American study that revealed each car share member that uses their sharing services

drives on average 40% fewer miles after joining the programme, reports a 46% increase in public transport trips, and the average household that uses the services reduces vehicle ownership by 50%. Zipcar (2010) went on to estimate that more than 120,000 vehicles have been removed from the road since the company started offering services. This study, whilst small in scale and over ten years old, offers significant insight into the opportunities for ongoing shared services, if offered in a flexible, convenient, and financially acceptable manner. Dia and Javanshour (2017) attempted to define the potential demand for shared, connected mobility opportunities, highlighting a significant reduction in vehicles needed to cover trips, and noting a possible increase in vehicle miles travelled. Similar studies have also been conducted with focuses on Lisbon (ITF, 2015), Stockholm (Rigole, 2014) and Austin (Fagnant et al., 2015). However, these studies, whilst offering a rich discussion around the potential for reducing the volume of vehicles needed for trips, do not offer insight into the potential opportunities or ramifications of shared autonomous transport on historical accessibility issues or cultural acceptance of such a system. Alongside this, chronic reliance on private vehicles in some countries, including the United States, will take significant disruption to encourage the uptake of new travel habits.

Cervero (2017) argues that modes which have typically not been used in areas in the Global North would provide enough variety to appeal to drivers, particularly those that do cannot currently access attractive alternatives. Suggestions on informal alternatives include smaller vehicles such as “jitneys” (vehicles which carry between 5-12 passengers) and commuter vehicles meant only for rapid transit of those travelling to and from areas of employment (Cervero, 2017, p.405). However, Cervero (2017) notes that personal use of these vehicle types stemmed from lack of ownership of a private vehicle, making the point that if private vehicles are not owned, an individual must seek out alternatives and is likely to either find other options or locate themselves, their education and/or their area of employment in an area where transport choices are available. Noting the recent need to promote integrated systems and new transport developments such as electromobility, Arias-Molinares and Palomares-Garcia (2020) argue that shared mobility is of particular interest to planners now more than ever.

## 2.7 Mobility as a Service

Similarly, to shared mobility and the sharing economy, MaaS is a not a new concept, but it has recently received significant attention from policy makers and transport planners, and academic researchers (Hensher, 2017; Jittrapirom et al., 2017; Merkert et al., 2020). To date, the concept has been viewed differently by actors engaging with the concept and, as such, there is a lack of

cohesion in understanding and overall definition of the concept, which, in part, has prevented the sustainable implementation of a MaaS system beyond the trial phase (Jittrapirom et al., 2017). However, concepts such as integrated transport have long been the goal of transport planners and policy makers.

Hensher (2017) argues that MaaS, facilitated by new technologies, offers travellers access to a range of different transport services via a single user interface, including public transport and on-demand services, which in turn offers increased flexibility, choice, and convenience without needing to own a private vehicle. This is echoed by Arias-Molinares and Palomares-Garcia (2020) who state that over 60,000 apps related to travel are available on Google Play, highlighting how technology has diversified access to information and services. Mulley, Nelson and Wright (2018) however, argue that a MaaS system is to offer transport or mobility as a single service to be available to users on-demand, formed of all transport modes including buses and rail. Bundling services and offering complete packages are also mentioned as a method of consuming transport in a MaaS system, along with offering transport that is reliable, flexible, affordable, and environmentally sustainable (Mulley et al., 2018). Slightly more technically, Hietanen (2014) describes MaaS as a mobility distribution model, suggesting that transport can be seen as an integrated ecosystem instead of individual modes. Alternatively, Kamargianni et al. (2015) argue that the essential MaaS components are intermodal planning and operations, along with payment and ticketing.

An integrated MaaS platform includes all mobility operators necessary to offer a flexible and bespoke service for everyone (Ultriainen & Pollanen, 2018). There is an expectation by Utriainen and Pollanen (2018) that integrated data, real-time data supplies and processing of supply and demand data in real-time will all be essential in a sustainable MaaS system. Alongside this, Utriainen and Pollanen (2018) class trip chains and flexibility to interchange between modes as central to the successful implementation of a MaaS system.

Smith et al. (2018) argue that there is no consistent definition of MaaS, stating that recently the definition has broadened further to include bundling transport modes into packages to provide seamless journey choices for users, and academic research has led to a range of definitions being created that encompass different components. These components may include connecting public transport and private vehicles on the assumption that seamless connections between the two is what is currently lacking (Holmberg et al., 2016).

Whilst no sustainable MaaS system has been achieved, academics have already begun speculating on what MaaS could look like in the future or 'MaaS2.0', with a combination of Software as a Service elements and Collaboration as a Service elements being integrated to allow transport operators to better integrate their services collaboratively and provide better options for their consumers, who they already have a detailed knowledge of (Merkert et al. 2020). Whilst there is no consistent definition of MaaS, or MaaS2.0 as highlighted above, the following sections detail noted key components that form the basis of MaaS, gathered from existing literature.

### 2.7.1 Key components

To offer a MaaS transport planning and delivery system, a range of seemingly independent systems must work together, including physical infrastructure and communications technologies which become accessible to the user via a digital device (Exposito-Izquierdo et al., 2017; Pangbourne et al., 2020). To date, there are ongoing discussions and disagreement around the core component of MaaS, with different articles and publications focusing on different aspects: Melis et al. (2016) consider the communications technologies and the use of data as being key to MaaS. Giesecke, Surakka and Hakonen (2016) offer a similar assessment but go on to argue that it's the recent advancements that allow for intelligent use of new technologies (such as communications and information) that will enable a sustainable MaaS system to be implemented. In contrast, Finger et al. (2015) imagine the key MaaS offer is the potential to increase transport integration. This is supported in part by Holmberg et al. (2016) who believe the ability to purchase travel services via one portal will offer more choices to travellers.

Clearly there is disagreement, but alongside this there are several components which feature in many publications (academic and non-academic) that discuss MaaS and the particulars of a MaaS system: integrating services for easier access physically and virtually (through online platforms), a greater degree of personalisation to transport services, being able to access a wider range of transport modes, and access to services instead of ownership. Alongside this, Arias-Molinares and Palomares-Garcia (2020, p.3) argue that the two basic conditions of MaaS are:

1. *"A robust public transport system*
2. *A growing and diverse shared mobility offer."*

This differentiation between public transport and shared mobility offers insight into the difference between mobility and transport, with transport defined as modes for moving from A

to B and mobility defined as access to employment, education, leisure, goods, and services. The incorporation of a shared mobility offer highlights the ability of residents and visitors to share access to an area (Arias-Molinares & Palomares-Garcia, 2020). Provision for disabled travellers could also be included in a MaaS system, offering a wider range of mobility options for travellers with additional mobility needs than has previously been possible (Ultriainen & Pollanen, 2018).

The development of a MaaS ecosystem is noted by Ultriainen and Pollanen (2018) as necessary for enabling the processing of all available transport mode data, along with consumer requests and the creation of trip-chains in real-time for multiple users simultaneously. This ecosystem will be a new approach to transport planning and provision and will require a new model for understanding ownership and responsibility, particularly relating to security and accessibility. The following groups are expected to be involved in a MaaS ecosystem: an overall MaaS operator; transport operators; local/transport authorities; technology and technical infrastructure companies (payment and ticketing).

### 2.7.2 The role of the Operator/Provider

Smith et al. (2018) argue that MaaS will be the first-time private organisations are actively playing a large role in creating public value in the transport sector. This development may then disrupt the role and relationship, along with organisational capabilities, of public transport authorities (Smith et al., 2018). For a MaaS ecosystem to function, there must be a trusted body who maintains the information availability, takes the majority of responsibility for ensuring data is stored and used correctly, and for ensuring the services provided meet the needs of the existing population.

Ultriainen and Pollanen (2018) state that a single operator or provider will be required, and that they will need real-time access to transport user information to offer a service to consumers. Similarly, Karlsson et al.(2016, p.3266) argue that a mobility broker is required, to "bridge the gap between private and public transport" and offer transport options that fit users' needs. Public administration input is cited as essential by Ultriainen and Pollanen (2018) for a system to be both sustainable and fair to all customers. Public officials are noted as the group that could be responsible for monitoring planning, pricing, and consumer protections. This conforms with Matyas and Kamargianni's (2018) argument that MaaS could be used as a soft mobility management tool, as the public administration could use the MaaS system to prioritise certain modes in line with public policy aims. However, whilst a transport operator may appear in a MaaS system, Brown et al. (2022) argue that there is also scope for incorporating the more

unique elements that are specific to different areas and relate to local challenges, which may influence which organisations are suitable to take on the operator/broker role.

However, Smith et al. (2018) argue that in order for MaaS to be sustainably implemented, a public transport authority must embrace and accelerate innovation internally and incorporate transport service operator offerings or enable greater innovation externally by supporting other actors taking on newer roles in the MaaS system. By highlighting that a new ecosystem approach would be required, Smith et al. (2018) reveal the internal, inter-organisational barriers that impact who will be the responsible actor for the MaaS system, along with the external barriers (namely, legislation) that will affect how the MaaS system will be designed, planned, and operated. Conversely, Hensher and Mulley (2021) note that the overall ownership and role of a MaaS operator may change based on the cultural and regulatory landscape within the area in which it is being developed.

### 2.7.3 Transport modes

Transport modes are critical to any transportation concept, but MaaS differs from traditional planning that predominantly considers cars, heavy rail, light rail, and buses, with some academics and professional bodies also naming on-demand and active modes as possible core components of a sustainable system (MaaS Alliance, 2017; Sakai, 2019; Sarasini & Sochor, 2017). The modal make-up of a MaaS system will differ by area, but overall integration between modes is frequently cited as required to offer convenience of access for users.

Public transport integration with other, more niche modes is cited as a key question by Ultriainen and Pollanen (2018), particularly as several modes are in direct competition with each other i.e. buses, cyclists and taxis can all operate in the same space. This correlates with Mulley et al. (2018), who view public transport as playing a crucial role in a MaaS system and note that public transport can incorporate fixed and flexible services but raises questions over the role of individual modes in an urban context.

In recent years, public transport has become easier to access due to technology developments improving ticketing and payment options, and journey planners offering real-time information to plan trips (Ultriainen & Pollanen, 2018). However, the ability to match customer expectation will mean disrupting current practices found in many cities (Hensher, 2017). Typically, public transport modes offer a point-to-point service, with trip chains being made to link points of interest by using connecting services. However, trip chains of this type would require

interchanging, which may reduce the attractiveness to some users as this may not conform with the idea of simple or seamless journeys (Hensher, 2017; Utriainen & Pollanen, 2018).

Self-driving cars are mentioned by Hensher (2017) and Ultriainen and Pollanen (2018) as a potential option to reduce overall ownership and vehicle downtime as neither drivers nor owners would be relied upon to operate the vehicles. Mulley et al. (2018) corroborate with this idea, going on to state that the MaaS model in its current form relies on the role of the car changing to a used but not owned mode. In its current form, car-sharing and ridesharing are noted by Ultriainen and Pollanen (2018) as potential alternatives to private car ownership, but both are noted as not being as truly convenient or flexible as owning a vehicle.

### 2.7.4 The role of information

Casado et al. (2020) argue that a MaaS system will utilise Information and Communication Technology (ICT) to both coordinate and provide transport services that will meet consumer needs. However, this means data will be required to both understand consumer need, plan transport provision, and evaluate whether the transport provision is meeting the requirements. To gather and use this information, agreements will need to be in place that allows information to be shared, a secure storage mechanism will be essential and agreements on data ownership and stewardship will be required in advance of the implementation of a MaaS system (Smith et al., 2020). Alongside this, conflicts in technical integration will need to be resolved. Smith et al. (2020) note that data providers and technical integrators will be required to facilitate the development and management of an operable MaaS system. This in turn will require a level of trust from the users, who may also require transparency in data usage before and during engagement with the MaaS platform (Cottrill, 2020). In a European context, data usage and security will need to conform to the General Data Protection Regulation (GDPR), which separate requirements would be needed elsewhere.

Alongside data security, storage and privacy, the ability of data systems to work both reliably in real-time and to be robust enough to collect information from a wide range of providers/sources and to inform transport planning and operational considerations is a key consideration of MaaS (Cottrill, 2020). The ability of MaaS actors to fully understand and utilise the different types of data will be critical. Cottrill (2020) and George et al. (2014) note some of the key data sources will be data held by governments, private data held by companies and individuals, passive data collected by third parties that is tangentially related to the

activities, data generated by communities (such as social media data) and data provided by individuals through tracking (i.e. through the use of applications or wearables).

## 2.8 Challenges

Several aspects of MaaS are considered challenging, with the level of difficulty to implementation varying depending on the regulatory, planning and operational structures already existing in the area in which MaaS would be implemented. However, some of the challenges can all be associated to the lack of specificity around the requirements i.e. flexibility, convenience and reliability are all mentioned frequently but are all relatively subjective to the individual user. Alongside this, it is not clear how best to re-configure existing transport systems, whether in part or in their entirety, to allow areas to fully benefit from implementing MaaS (Becker et al., 2020). The following points have been raised in academic and non-academic literature as requiring further consideration:

- Utriainen & Pollanen (2018) state that public transport in its current form cannot provide a service level that would be required in a MaaS system, due to having fixed routes and stops and a general lack of flexibility to meet consumer needs
- Mulley et al. (2018) note scalability, interoperability and institutional barriers represent key challenges to the implementation of a sustainable MaaS system. Karlsson et al. (2016) corroborate with this but go on to argue that the challenges associated with designing a system are not technical but are instead related to the service model i.e. user group, ticketing and pricing and customer support.
- Initial investment, public administration support, long-term planning and the reduction of institutional barriers are all noted as being key to the implementation of a sustainable MaaS system by Karlsson et al. (2016).
- Data protection, access and potential cybersecurity breaches are noted as concerns by Ultriainen and Pollanen (2018). Ensuring there are actors within the MaaS ecosystem that fully comprehend the risks and have knowledge of the possible mechanisms to lower the risks is highlighted as key.
- Business planning associated with often changing environments, requirements and consumer expectations is noted as an area of concern by Mulley, Nelson and Wright (2018). Smaller businesses with limited ability to reach a wider geographical area and deliver services to many clients may suffer in the initial start-up of a MaaS system.
- Mulley et al. (2018) note that many MaaS definitions require the use of some form of technology to access. How older people accessing mobility will be considered when

designing and implementing a MaaS system will be critical to ensuring proportions of the population are not prevented from accessing transport modes and opportunities.

## 2.9 Positive benefits and expected effects

Several benefits are often mentioned in relation to MaaS, particularly outcomes that are perceived to be benefits to the individual user, such as: personalised mobility; seamless and interconnected travel and accessible transport (Berg et al., 2022; Mulley et al., 2018). Alongside this, benefits to non-users including decreasing vehicle traffic and emissions are both mentioned by Ultriainen and Pollanen (2018) and Berg et al. (2022) as being potential positive benefits of MaaS.

From a transport planning perspective, more efficient use of a wider range of modes by users, cost-efficiency of operations and future transport investments, and uptake in sustainable modes are all cited as potential benefits of a MaaS system by Ultriainen and Pollanen (2018). Benefits for the public sector and public administration are noted as: efficient allocation of supply to meet demand, a more effective transport network and economic and education growth based on greater access to transport services (Berg et al., 2022; Mulley et al., 2018).

Mulley et al. (2018) also note benefits for businesses. However, these benefits relate to the potential for new markets associated with a MaaS system and do not relate to commercial opportunities currently available i.e. “innovative service concepts” are noted as a benefit to businesses as opposed to “increase in users” or “reduction in operational costs” (Mulley et al., 2018, 585). However, noting the lack of sustainable implementation currently anywhere in the world, and the lack of agreement on an overall definition of MaaS, the European Commission (2016) notes there is no evidence yet on the costs and benefits of a MaaS system. Whilst short term trials such as the European funded MaaS4EU project aim to provide more clarity around the range of options that could be incorporated into a MaaS system and how it could be led, without longer term data on how a system has been implemented regional, national and international bodies are unable to determine how it may benefit their areas (MaaS4EU, no date).

## 2.10 Areas for Further Research

Tyrinopoulos and Antoniou (2013) state that issues faced by cities, due to the increase in mobility demand, requires a collective effort, with multiple actors engaged in the process to solve challenges. Sochor et al. (2015) agree with this in part, arguing that a radical new approach will be needed to really meet the urban mobility challenges that lay ahead and to

ensure future development is sustainable. Kamargianni et al. (2015) agree with this position, and they go to state that new and innovative solutions are needed to increase the slow and steady shift towards sustainable mobility services. However, the need to fix the many problems has meant that a relatively undefined concept has been given significant attention that isn't based on empirical evidence, with Ultriainen and Pollanen (2018, p.6) even stating: "MaaS trials can have an enormous role in changing people's mobility patterns."

A limited (but growing) range of research exists that discusses MaaS and shared transport systems, and their core components, but very little has been addressed in the following areas:

- The role of the public and private sectors in a sustainable MaaS system;
- The scope of a MaaS system, with practical consideration for transport authorities and operators i.e. a single city, a city region, or a multi-region approach;
- The role of MaaS in providing equitable transport services in decentralised residential areas;
- The possible regulatory changes required to support a sustainable MaaS system;
- The possible impact of a MaaS system on traditional public transport usage; and,
- Scenarios for MaaS implementation at a suitable level.

These areas specifically have formed a key part of the research in this thesis, by providing a backdrop of known knowledge gaps. The information gathered as part of this research has aimed to add to the knowledge in these areas specifically where possible, to ensure a unique contribution to knowledge has been made alongside improving the overall knowledge of MaaS specifically.

A lack of research has been conducted that demonstrates the interoperability of a number of systems that would be required to work in tandem, to support a sustainable MaaS system (Exposito-Izquierdo et al., 2017; Mirri et al., 2016). One piece of research does attempt to shed light on how a MaaS system may be structured: Mirri et al. (2016) states that in future, MaaS will comprise of a range of micro-services (as opposed to large scale, single operator services) that will all own their own data streams, which will require aggregation to a larger platform in order for MaaS to succeed. Mirri et al. (2016) go to state that this may enable individual users to have greater control over their data and the shape of the MaaS system, as fewer people would be needed to have a large impact on a service.

Research investigating possible opportunities associated with new technologies and MaaS has so far been scarce. Some research has focused on shared autonomous vehicles, but with a particular interest in how many trips can be covered with fewer vehicles (Dia & Javanshour, 2017; Fagnant et al., 2015; ITF, 2015; Meyer et al., 2017). Whilst this is a helpful starting point for what could be achieved with autonomous vehicles, this research does not offer insight into the practicalities associated with a shared autonomous vehicle system i.e. management, operations, data owner and controller etc. Alongside the above points, a lack of research exists in transport focused journals on the application of shared mobility more generally (as highlighted in section 1.9).

As demonstrated, the range of considerations and possible barriers to implementation for MaaS are many. However, the transport industry is changing rapidly, due to the emergence of more players in the arena from different sectors, including the technology industry that is traditionally more innovation inclined (Mirri et al., 2016). With this in mind, further research on the practical considerations of MaaS and the challenges associated with the delivery of this type of transport system is needed to inform policy and regulatory changes.

## 2.11 The post-COVID city

The COVID-19 pandemic caused millions of deaths globally. Alongside this, the pandemic disrupted the daily lives of billions, cities of all sizes, and regional and national economies (McClelland et al., 2022; Mouratidis, 2022). Many of the impacts were at the time unforeseen and it has now been recognised that many governments and countries did not have sufficient capacity or capability to plan for and manage such disruption (McClelland et al., 2022). In the case of transport, cities have seen the reduction of transport provision in response to lockdowns and lack of users, and an inability for public transport to meet user needs following the reopening of cities after lockdown (Caulfield et al., 2021). This wildly differing set of requirements, from very few users during lockdown to high volumes following reopening; in turn this has had impacts for transport providers, leading to overcrowding by passengers and cancellations of services due to a lack of staff (Hsieh & Hsia, 2022). To broaden the range of transport modes available, some cities implemented temporary (and in some cases permanent) areas to support safer and easier access to active modes such as cycling and walking (Fuller et al., 2021).

Following the reopening of cities, policy and decision makers have an opportunity to recover in a way that incorporates a number of changes in support of policy goals, including those related to reducing carbon emissions and achieving net zero (HM Government, 2021;

Mouratidis, 2022). Hensher (2022) argues that the key challenge for policy makers will be to encourage users back onto public transport and away from private vehicles, which they may see as less of a potential risk to health. Hensher (2022) goes on to argue that several modes associated with MaaS, including active modes such as bicycles, e-scooters and walking could be more obvious options for users looking to avoid modes which require users to share confined spaces with other travellers. Whilst it is unclear how MaaS may feature in a post-COVID city, the interest policy and decision-makers are taking in ensuring recovery meets long-term goals could provide an opportunity for MaaS to be realised.

## 2.12 Chapter Conclusion

With policy and decision makers looking to new opportunities to deliver transport services, MaaS may provide an alternative way to plan for and delivery transport to users. However, with no existing system in place, limited data is available to support system developments and gaps in knowledge remain. The next chapter will detail the methodological approach taken in this research.

# 3 Chapter Three: Methodology

This chapter details the methodological orientation of this research. It highlights where the research is placed in relation to research philosophies and how it has been guided by research principles, along with the tools that have been used to gather information. Following Silverman's (2020, p.26) proposed four components, the methodology is made up of:

1. *"A preference for certain methods among the many available to us*
2. *A theory of scientific knowledge, or a set of assumptions about the nature of reality, the tasks of science, the role of the researcher and the concepts of action and social actor*
3. *A range of solutions, devices and stratagems used in tackling a research problem*
4. *A systematic sequence of procedural steps to be followed once our method has been selected."*

Noting the four categories above, the first section of this chapter details the philosophical foundation on which the research was conducted, the second section highlights the research techniques utilised and relates them back to the philosophical underpinnings, and finally, the third section considers the practicality of approach, specifically relating to the broad concept of MaaS and how the research has attempted to ground it in a single geographical area. By splitting the sections in this way, the chapter offers a clear logical narrative and highlights the links across the results chapters.

As this research is based on a concept without a single unified definition, it was important to initially develop an understanding of a range of views on the different definitions and requirements for a MaaS system, noting the barriers and key requirements for implementation. However, whilst understanding a range of views on the definition is important, it was also essential to understand how this relates to current travel and policies using a case study that allows for practical consideration of the challenges of implementation and also the potential benefits.

To offer both depth and contextual perspective, three research methods have been utilised: semi-structured, in-depth interviews; a thematic analysis of transport and urban planning policies in the Greater Manchester area and further afield; and, an empirical analysis of transport data in the Greater Manchester area. The techniques utilised in this research are embedded in social sciences and this is reflected in the philosophical roots of this research.

This approach has been informed by my professional positions within the transport planning industry. In particular, the experience gained whilst working on projects which related to innovation within the context of transport planning in Greater Manchester, has informed how this methodology was developed. The intention to complete a piece of research that would be of practical use to the case study area and to other cities and city regions has influenced the philosophical approach, the methods chosen to gather data and the types of analyses conducted.

## 3.1 Philosophical roots of this research

MaaS is an often-ambiguous concept, based on what can be described as an attempt to create a perfect transport system, where consumer benefits are kept at the heart of planning and operations i.e. reliability, flexibility, and convenience (Smith, Sochor and Karlsson, 2018). As chapter two shows, no singular definition exists for MaaS exists. In its place, transport planners, technologists, futurists, and innovators related to the field of mobility continue to offer ideas on key components that loosely form the basis of an assumed definition. These components are firmly rooted in their beliefs and understanding of what is required to create a MaaS system, but these components are often not considered for their commercial or regulatory implications first. Due to these considerations, this piece of research is predominantly concerned with gathering opinions rooted in experience or belief and reconciling them with local policy and historical data to offer context on the future of MaaS in Greater Manchester.

Dewey (1922) and Morgan (2014) argued that experiences and actions are social and linked to experiences previously had, and as such: all experiences are rooted in social history. Following on from this, Dewey's concept of inquiry sought to reveal answers that are likely influenced by current beliefs (to questions of future action) and in place of applying a single, linear process to finding answers, Dewey assumes beliefs, understanding and previous actions influence the process of research throughout the complete cycle (Morgan, 2014).

Pragmatism is rooted in the belief that each actor making a decision is acting within their own definition of the situation, the definition itself being rooted in previous actions and the actor's own historical social experiences (Hall, 2013; Morgan, 2014). Talisee et al. (2008, p.31) argue that pragmatism is based on three views concerning knowledge:

1. *"Relativism: the case for any standard of knowledge cannot avoid begging the question, and hence, no standard of knowledge is privileged.*
2. *Historicism: standards of knowledge and justification are socially and historically dependent.*

3. *Anti-cognitivism: truth is not the goal of inquiry."*

Morgan (2014, p.4) states that "Dewey's philosophical agenda is highly relevant for social research today, because he sought to break down the dualism between realism and idealism". However, pragmatism has faced criticism in human geography and is often considered to be an "anything goes" philosophy that prioritises creativity over realism (Barnes, 2008, p.1542).

In support of the pragmatist philosophical approach, Barnes (2008, p.1543) argued:

> *"For pragmatism is not equivalent to crude epistemological relativism: every view is as good as every other, and so there is no point in believing anything. An neither is it equivalent to crude ontological relativism: we make the work as we see fit, defying gravity at whim and flouting the molecular structure of building materials at will."*

### 3.1.1 Ontology, Epistemology and Pragmatism

Ontology refers to theories relating to 'being' and what exists, including the nature and structure (Rawnsley, 1998). As a branch of metaphysics, Ontology attempts to describe "the nature of things as they are" (Rawnsley, 1998, p.2). In contrast, Epistemology considers knowledge, including the theory and nature of how knowledge is created. Shaw et al. (2010, p.513) note that studies that look to highlight or find "cause-effect" relationships are often viewed as taking a "positivist or empirico-analytical stance". In contrast, studies which are "open-ended…seeking understand and lived experience" are viewed as taking a "constructivist or interpretivist" approach (Shaw et al., 2010, p.51). In contrast, Dewey (1929) argued that inquiry was the emphasis of research and therefore refocusing on inquiry in place of ontology and epistemology was critical when considering the nature of human experience. Following on from this position, Dewey (1929; Morgan, 2014, p.1048) goes on to argue that outcomes of inquiry itself go on to form the basis of belief, leaving in place of knowledge the creation of "warranted assertions" (warrants being the outcome of enquiry itself). Morgan (2014, p.1048) corroborates with these statements, stating that both ends of the spectrum (post-positivism and constructivism) are equally important when making claims about the human experience:

> *"On one hand, our experiences in the world are necessarily constrained by the nature of that world; on the other hand, our understanding of the world is inherently limited to our interpretations of our experiences."*

With this in mind, by utilising the pragmatism paradigm, this research adopted processes and techniques embedded in both positivist and constructivist practices, to create a mixed methods

approach to the study. This is reflected clearly in the methods used, specifically: the mixture of qualitative and quantitative methods.

### 3.1.2 Pragmatism and this research

Due to the nature of this research, pragmatism has heavily influenced both the process and the analytical framework for which the data gathered is considered. When considering new concepts that differ significantly from the current state of play, the opportunity to be creative in both constructing and shaping the concept means those who responded to the interview requests were likely to have either an open-minded view on what could be achieved or a fixed view on the limitations or barriers to allowing as MaaS system to be implemented and sustained (Arar & Oneren, 2016). Their experience in their field amongst the relevant communities in which they're embedded will have guided their beliefs to this point, along with their beliefs of what could be achieved in future, impacting their perspectives and therefore responses (Hall, 2013). This correlates with Dewey's (1929; Barnes, 2008, p.1554) argument that "it was our own Interests, values and purposes that helped make truth" and James' (1920, Barnes, 2008, p.1554) statement that "the knower is an actor and coefficient of the truth". To ensure the relevant information was captured, suitable techniques that reflect the philosophical underpinning of this research were required and are detailed in the next section of this chapter.

## 3.2 Methods used in this research

Noting the conceptual nature of the topic, the methods to be utilised in the research took some thought to ensure the final research output was not a shallow consideration of the topic and instead offered insight not previously captured elsewhere. Qualitative methods offer researchers a mechanism to explore and understand the context behind experiences and opinions of those related to or impacted by a specific topic (Maxwell & Reybold, 2015; Silverman, 2006). In seeking to refrain from bias, qualitative research aims to understand the points of view of those who take part in the research rather than imposing a preconceived theory on the participant and their opinions (Maxwell & Reybold, 2015). Whilst no research is conducted in a theoretical vacuum, this aim allows the researcher to achieve an "emic account": one in which the participants denote the meanings in statements as opposed to researchers enforcing theories on them (Maxwell & Reybold, 2015, 686).

In contrast, quantitative methods offer the ability to assess the impact and effects of causes of relationships between data on a subject or topic (Connell, 2016). The human world is continuously subjected to attempts to create statistical explanations for concepts and occurrences, whether to examine current practices or give a reason for changing them

(Balnaves & Caputi, 2001). When considering the impact of a concept on a geographical location, context is required to ensure the assumptions are relevant and overall the evaluation is grounded in reality. The use of quantitative data enables additional perspectives to be captured, if employed intelligently, and offers context relating to the current state of play. Table 1 illustrates the differences between qualitative and quantitative methods in more detail.

**Table 1: Quantitative and qualitative research methods. Source: Selltiz, Jahoda & Deutsch (165, 2)**

| **Method Type** | **Description** |
|---|---|
| Quantitative research | The purpose of research is to discover answers to questions through the application of scientific procedures. These procedures have been developed in order to increase the likelihood that the information gathered will be relevant to the question asked and will be reliable and unbiased. To be sure, there is no guarantee that any given research undertaking actually will produce relevant, reliable and unbiased information. But scientific research procedures are more likely to do so than any other method (Selltiz, Jahoda & Deutsch, 1965, 2). |
| Qualitative research | Qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative |

| Method Type | Description |
|---|---|
| | researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2012, 6-7). |

When considering patterns of behaviour and relationships between components or variables, quantitative research methods may be utilised in an experimental setting (Roberts, 2014). However, how the relationships were established and their reason for forming may also be of interest and is not easily captured in empirical data sets. In this case, qualitative methods may be required to offer "qualified objectivity" (Roberts, 2014, p.2). In the case of this research, one type of method offered a background or context to the potential vision to be created, and the other ensured any vision created is rooted in the facts of the area in which it is based. This corroborates with Fredriksson et al. (2021) who note that mixed methods allow transport researchers to better understand new areas via qualitative methods, whilst also understanding the potential impact they might have using quantitative methods. Alongside this, Shaw et al. (2010, p.515) argue that mixed methods research is grounded within pragmatism, offering researchers an opportunity to ensure their work is "outcome orientated" and "attends to the importance of context".

In reflection of the above, a mixed methods approach has been utilised in this research, offering the ability to provide evaluative judgement on the data gathered with the aim of responding to the main research questions (Hall, 2013). As highlighted in figure 1.4, each method also directly impacts one of the core questions and/or research outputs. The methods used have reflected the paradigm of pragmatism, particularly the intelligent application of the methods with the intent to develop and improve understanding of the research and how the data analysis is applied throughout the research (Dewey, 1938).

The following sections detail the use of a case study area and the individual methods utilised in the research. Each method in this study was chosen to target at least one of the research questions (detailed in section 1.2), which look to determine existing gaps in MaaS knowledge and transport provision in Greater Manchester, to better understand how cities have applied innovative approaches to date and whether they're considered MaaS, and how MaaS may

contribute towards resolving the key challenges faced by Greater Manchester (and other cities and city regions of similar size and composition).

### 3.2.1 The use of a case study

The case study as a research strategy is well established in several academic circles, particularly in the social sciences (Edwards, 2019; Simons, 2009; Yin, 2003). However, Edwards (2019) argues that in recent years case study research has not featured prominently or been considered as equal to other methods. Edwards (2019) goes on to argue that whilst this may be the case, case studies should be the foundation on which observations are made.

Quoting Yin (1994, p.13), Simons (2009, p.20) states the following two points as potential characteristics of a case study:

1. *"Investigates a contemporary phenomenon within its real-life context, especially when*
2. *The boundaries between phenomenon and context are not clearly evident."*

The use of a case study allows researchers to investigate the context of an occurrence using a range of data types from different sources (Baxter & Jack, 2008; Simons, 2009; Yin, 2003). This type of analysis offers value for researchers when critically analysing the potential impact of an intervention (Baxter & Jack, 2008). By using a case study area, it ensures multiple layers and viewpoints are explored and understood, and the impact of an intervention understood with a depth that is largely unachievable when considering the intervention as an abstract topic. However, there are different types of case study and the applications of methods associated with each varies.

Drawing knowledge and information from a case study, to offer other researchers and the wider community value beyond a single engagement requires consideration beyond the choice of what or where (Morgan, 2018). In the case of this research, a city region (Greater Manchester) was chosen as an intrinsic case study: the use of the city region in the research was to offer additional insight in relation to the wider research question (Stake, 1995). Using multiple data sources on the city region, including the local transport policies and data on current transport patterns, the case study enabled a range of perspectives to be captured and generated, including the publicly declared intentions of influential actors such as the transport authority (Simons, 2009). Greater Manchester itself was chosen as it represents a typical British city region that faces the same challenges as many other cities of its size, including congestion and pollution. Alongside this, its faced similar challenges relating to the privatisation of transport services

and the impact this has had on transport planning in the wider context, including creating services that offer some of the previously noted key components of a MaaS system: flexibility, reliability, convenience, and affordability. Finally, Greater Manchester is undergoing a process of devolution. This means that the Greater Manchester Combined Authority, TfGM, and the city region Mayor, have an increasing amount of authority within the city region area in comparison to other cities in the UK. Whilst they do not have complete autonomy or control, they are increasingly able to make the case for changes and interventions that would not have been previously feasible.

By bounding the case study into a single unit (Simons, 2009), the data gathered and analysed within this research was directly compared or applied into the geographical area. The expert interviewees are not all based in the city region, which prevented their judgements being clouded with any expertise on the influencers in the city region or their personal experiences in the city region. An initial primary boundary of the entire city region was applied, but data related to the fringes of the city region was not disregarded. Alongside this, a secondary boundary of the regional centre (the main city within the Greater Manchester, which also encompasses Media City which is located outside the city centre boundaries) was considered and applied early on. Again, this did not reduce interest of exploration into the wider city region but was decided as many of the initial studies relating to MaaS and the opinions of the expert interviewees predominantly considered urban areas.

The use of a case study is appropriate in this research to offer both context and ground the research in a unique situation that has resulted from transport planning choices over time (without a case study area the research could quickly be drawn into a purely theoretical debate, which is not the purpose of this study). The case study features heavily in the policy review and transport data research chapters, but predominantly features in the final vision, which was created because of the research conducted throughout this study.

#### *3.2.1.1 Case study design*

Whilst open-mindedness was key throughout the research, to prevent limiting the possible areas for investigation, a case study strategy was loosely developed to ensure the work did not expand beyond the realms of this study or the research questions. The following points were created to mirror the wider research questions and apply focus to the case study as a research tool (Simons, 2009):

- What are the key transport patterns in the city region, and how have they evolved over time?
- How do the opinions of the expert interviewees relate to transport patterns currently found in Greater Manchester?
- What are the policy intentions for transport and mobility in Greater Manchester and how do these compare to the current transport use patterns?

By forming these three questions, it kept the case study routed in the wider research and prevented excessive inquiry into areas unrelated to the wider research (Baxter & Jack, 2008).

#### *3.2.1.2 Greater Manchester as a case study*

Greater Manchester was chosen as the case study area as it represents both a city region that has benefited from significant economic and population growth and an area that suffers from a number of transport related challenges including congestion, poor air quality as a result of polluting emissions, physical and mental health issues as a result of transport choices and accessibility issues (including physical access to transport modes, affordability and poor integration of transport infrastructure and service patterns). The challenges faced by the city region are similar to other cities of its size and is therefore in the process of setting similar goals to overcome those challenges (Agyemang et al., 2017; Rodriguez-Pose, 2008). Two documents that have played a key role in setting local goals to improve the city region (including the transport network) are the Greater Manchester 2040 Transport Strategy and the Greater Manchester Strategy. In response to political restructuring (more information can be found in the next chapter) the city region now has more power to make changes to transport and urban planning, including establishing a city region wide spatial framework that will serve as the development framework for future years. Alongside this, its city region status enables it to also become "driven by the narrative of global competition" alongside other city regions in the global North and South (Kim, 2020, p.2). This chimes with the city region's ambitions to attract and utilise new innovations and talent to improve public services, employment opportunities and education.

Whilst the research has focused on Greater Manchester, the research outputs will be of use to other city region areas of a similar size and similar conditions. This allows for the research outputs to be of greater interest than just in Greater Manchester alone and will therefore add more to the MaaS debate.

### 3.2.2 In-depth, semi-structured interviews

In-depth interviews were chosen as the appropriate method to answer (in part) research questions one and two, which focus predominantly on the challenges and barriers of implementing MaaS, along with the potential benefits a MaaS system may bring to cities.. Interviews as a method are a fully established and well-known qualitative choice to gain insight into perceptions, opinions and beliefs (Delyser & Sui, 2014). Hitchings (2012) argues that interviews offer greater insight than considering the choice of words alone. Simon (2009, p.14) argues there are four key reasons for utilising interviews as a research method:

1. *"To document the interviewee's perspective*
2. *To actively engage in the topic and broaden the researcher's ability to identify and analyse issues*
3. *The inherent flexibility it offers to change direction to pursue emergent issues or probe a topic*
4. *The potential for uncovering and representing unobserved feeling and events that cannot be observed."*

As the concept of MaaS is still relatively undefined, choosing the right groups to interview and maintaining a rigid set of expectations could have potentially limited the quality and depth of data gathered, particularly when considering the range of industries and actor specialities involved. Due to this, methods associated with grounded theory, such as allowing the sampling to refine the direction of the next set of sampling (Silverman, 2006), offered a mechanism to seek out actors and experts beyond traditional roles in transport planning and therefore influenced this work.

Initially, ethical approval was sought, and obtained, for between fifteen and twenty interviews with key decision makers, transport operators and potential stakeholders in MaaS and fifty to sixty interviews with members of the public. However, ongoing investigation into academic and professional literature highlighted the ambiguous conceptual nature of MaaS and therefore interviews with members of the public were removed as it became evident there would be low to no awareness of the concept outside of professional and academic spheres. In place of interviewing members of the public, the interviews with those within or related to the field of transport were upscaled to include a wider range of topics related to MaaS and current transport challenges. This ensured the following were achieved: a high-level understanding of MaaS was gained; opportunities and any potential barriers for the uptake of MaaS across the city-region were detailed; and opinions on potential positive and negative impacts of MaaS in Greater

Manchester were captured. The participants were selected from organisations that offered a diverse insight into MaaS (diversity being essential in the pragmatic approach (Barnes, 2008)), rooted in their beliefs and experiences of the current transport system from the perspective of their professional experience. Table 2 details the types of experts targeted in this research.

**Table 2: Expert types participating in this research. Source: author**

| Expert type | Reason for inclusion in research |
|---|---|
| Transport planners | Expert in current transport systems |
| Transport economists/appraisal experts | Experts in how transport systems are appraised prior to implementation. This is particularly useful for the economic case for implementation (or to avoid implementation) |
| Transport innovation experts | Experts in some of the more novel or newer elements of transport planning and operations. These experts will likely have heard of MaaS |
| Sustainable transport experts | Experts in sustainable transport can inform how a MaaS system could partly enable the green ambitions of Greater Manchester (or give reasoning on why it might not) |
| Technology (transport innovation) experts | Accessing transport is becoming increasingly digital, and a MaaS platform will likely include an application or digital method for payments. These experts could inform how it might look or work |
| Accessibility and mobility groups | Experts in accessibility and mobility (including for those with additional mobility needs) could inform the parameters of a MaaS system and its operational setup |

The participants were selected using a purposive sampling technique, based on their knowledge of the transport industry as it currently operates, knowledge of MaaS or shared mobility concepts, or knowledge of intelligent or smart mobility concepts that may be applicable to a MaaS system. Experts from sectors which may be impacted by changes in transport planning

and service delivery, in a shared mobility system, were also invited to participate. These participants came from the health, social care, transport, and environment sectors. The sampling technique of purposive was used to identify new potential interviewees as the interviews progressed. The purpose of the interviews was to create a knowledge base of what MaaS could be generally, and what it could be in relation to Greater Manchester transport.

#### *3.2.2.1 Analysis*

Adapted from Taylor, Bogdan, Robert and DeVault's (2016) recommendations, the following process was used for the collection and analysis of the interview data:

- The interview was recorded using a voice recorder on an iPad
- The recordings were listened to in full by the researcher after each interview took place
- The interviews were transcribed by the researcher

Notes were made throughout each interview, to ensure thoughts were captured to inform both future questions and assist with the analysis. The interviews were coded in two phases: the first to capture a wide range of interest points, and the second to bring together the points under the umbrella of different themes. The Braun and Clarke (2006, 87) six step process was used to guide the thematic analysis of the interview data:

**Table 3: Six steps of thematic analysis. Source: adapted from Braun & Clarke (2006)**

| Phase | Task | Description |
|---|---|---|
| 1 | Familiarising yourself with your data | Reading and re-reading the data, noting down initial ideas |
| 2 | Generating initial codes | Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code |
| 3 | Searching for themes | Collating codes into potential themes, gathering all data relevant to each potential theme |
| 4 | Reviewing themes | Checking if the themes work in relation to the coded extracts and the entire data set, generating a thematic 'map' of the analysis |
| 5 | Defining and naming themes | Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme |
| 6 | Producing the report | …relating the analysis back to the research question and literature, producing a scholarly report of the analysis |

#### *3.2.2.2 Ethical considerations*

Prior to participating in the research, the interviewees were given a written consent form that detailed how, where, and why the information collected would be used. Each participant was asked if they were happy for their name, job role and employer to be included in the transcription and were given the option to choose to limit which of these were included. A list of participants, including information each participant approved for inclusion, the information sheet provided to participants and the participant consent form have been included in appendices A, B and C.

The research conducted was given ethical approval prior to being commenced and followed the University of Salford's guidelines regarding data protection, which included the Data Protection Act 2018 (the UK's implementation of the General Data Protection Regulation).

This includes limiting the use of the data to only what's necessary and storing it securely. The ethical approval letter has been included in appendix D.

### 3.2.3 Policy review

A policy analysis and evaluation method was adopted to answer research question number three, which considers existing best practice developed by cities around the world implementing measures which could be classed as innovative. Document reviews typically feature in mixed-method research, offering a way to support other research methods by offering greater context (Bowen, 2009). A policy review as part of this research enabled the gathering of information that offered greater insight into the current local context and future intentions of the Greater Manchester area. The policy review focused initially on one document: the Greater Manchester 2040 Transport Strategy. This Strategy is the main transport document offering policy and strategic intentions for the city region up to the year 2040. Upon completion of this review, additional policy documents at a local, regional, and national level were critically analysed as well.

Critical policy analysis has been a research methodology in a range of industries, particularly the social sciences, for some time (Rata, 2014). At its simplest, policy analysis is a study that enables academics and wider parties to critically assess policies and any gaps that have arisen between policy and intent, and implementation or development (McTigue et al., 2018). However, policy analysis can also be undertaken prior to intervention or scheme implementation, as part of a content or design analysis considering the wider policy narrative and evidence used to support the policy objectives.

In the policy design process there are several stages that are traditionally completed (Akgun et al., 2019): initially, policy makers will investigate the problems that require intervention and their possible root causes; secondly, actions or interventions that would solve, reduce, or remove the problem are considered, with the benefits and costs being evaluated; finally a selection of goals and associated actions are made (Howlett, 2014; Marsden & Reardon, 2017).

#### *3.2.3.1 Policy document selection*

Two types of policy documents were selected: documents local to Greater Manchester and documents from other cities. Two documents from Greater Manchester were reviewed: the Greater Manchester 2040 Transport Strategy and the Greater Manchester Strategy. They were chosen as they're the most recently published goal setting policy and planning documents meant for transport and wider city region growth and development. Alongside this, 74

additional documents were selected from other cities. These documents were selected from global cities, noted as part of an established "innovation index". The innovation index is calculated each year as part of the Innovation Cities Programme. The Innovation Cities Programme was chosen as it's the longest running programme of its kind which uses clear indicators for all cities indexed, leading it to determine a rank for 500 benchmark cities. Of these 500 cities, the top 30 have been selected and their transport and city policy documents have been reviewed. The following documents were selected for review from each city:

- Most recently published transport plan or strategy
- Most recently published city/urban plan or strategy

In the event a combined plan was found, or an alternative type of document was published in place of the two documents noted above, these alternatives were considered instead. Only English versions were considered. If an English version was unavailable, the city was not included in the list. Table 9 in chapter seven details the cities included and the ones unable to be included, along with the reason.

This index was chosen as it has an established history of being well-regarded by both public authorities, businesses, and media publications. Alongside this, the indicators are available for scrutiny and include transport measures. The index has also been previously noted as a smart city index in academic literature, including Lai and Cole's (2022) paper which reviewed smart city indexes.

Bloor and Wood's (2006) recommendations on choosing appropriate keywords was followed and the following terms were used to search for policy documents:

- [city name] transport strategy
- [city name] transport masterplan
- [city name] transport plan
- [city name] mobility plan
- [city name] mobility strategy
- [city name] city strategy
- [city name] city masterplan
- [city name] plan

#### *3.2.3.2 Document review process*

Initially the Greater Manchester 2040 Strategy was reviewed with an open mind, to holistically understand the intentions, evidence cited and policy goals and implications of the document. The document was then discussed in a way that offers a rich description of the whole text, to give sufficient contextual information (Braun & Clarke, 2006).

The remaining documents, alongside the Greater Manchester 2040 Transport Strategy, were then reviewed as part of a theoretical thematic analysis. The purpose of the thematic analysis was to uncover emerging themes in the policy document under consideration. Nvivo was used as part of the coding process and figure 7.4 highlights the categories used as part of the review (Braun & Clarke, 2006). A hybrid approach was taken to analysing the data, with an inductive approach predominantly used as the multiple read-throughs guided the coding and categorisation of the data. However, alongside allowing the data to create categories, one set of categories was prepared in advance, which aligns more closely with a deductive process (Braun & Clarke, 2006). The reason for this is, as the interviews generated insight into the potential components of MaaS, these were used to investigate whether the Greater Manchester 2040 Transport Strategy already considered some of these components in its strategic development plan for the future of transport in Greater Manchester. By using both methods, the policy documents were analysed from multiple sides and able to provide additional insight into the future intentions of the cities.

This approach was chosen as it offers a way to organise, analyse and report on themes within the documents (Braun & Clarke, 2006), in relation to the wider research topic. Whilst some researchers believe thematic analysis should be considered as part of a wider research approach (Boyatzis, 1998; Ryan & Bernard, 2000), in this case it will be used as a standalone method in its own right to complement the other methods being utilised as part of the wider research (Braun & Clarke, 2006). Utilising a theoretical thematic approach complemented the initial holistic read through and allows for the literature to be engaged with early on in the thematic analysis process design.

Rubin and Rubin (1995) state that thematic analysis can offer exciting insights into data as it allows the researcher to discover themes that had not been obviously stated in the data. The use of thematic analysis in this context was not about giving voice to the document under scrutiny, but instead offered a way of discovering the nuances within the texts that may or may not link the policy documents and intentions within them to MaaS or other shared mobility concepts.

In relation to the Greater Manchester 2040 Transport Strategy, a theme will be counted as a theme if it captures something important about the data in relation to the wider research interest: whether it relates to shared mobility, MaaS specifically or the key components associated with MaaS based on interviews conducted to date. Following Braun and Clarke's (2006) approach, the number of uses of a theme within the data did not necessarily denote the importance or cruciality of that theme. Alongside this, the number of instances a pattern was found will not denote whether the pattern constitutes a theme within itself. Judgement was used to refine the themes and a certain degree of flexibility was maintained to ensure emerging themes were not missed.

A semantic approach to the thematic analysis was utilised, to find the themes that were specifically noted within the documents, instead of attempting to understand the meaning behind the themes in the document. This approach was chosen as the policy goals within the documents relate strongly to solving wider challenges that are present today as opposed to considering previous iterations of literature to find a wider meaning. The insight gained from these documents support research questions one and three, providing wider context on how MaaS and the potential components of MaaS are being considered within transport policy within and beyond Greater Manchester.

### 3.2.4 Analysis of transport data in Greater Manchester

A quantitative method to analyse transport data from Greater Manchester was developed and used to answer research question number four and to inform the answer to question number five. This method formed part of an overall mixed methods approach. Brannen and Moss (2012) argue that mixed method research approaches allow for qualitative and quantitative data to be utilised, to support the position of seeing a research question or objective, along with data gathered in support of either, through multiple lens', preventing a single-sided viewpoint from emerging. Brannen and Moss (2012) go on to argue that mixing methods also supports researchers from different specialities applying their competencies and expertise to a wider range of data, and therefore offers a greater degree of insight than what can be achieved otherwise.

The role of transport data within this research was to provide both context for the case study location (detailed in chapter five), to challenge the policy document analysis and to allow for the assessment of whether conditions exist in the city region for the creation of MaaS system. Alongside this, Greater Manchester is a pioneer example city region as one of the first in the UK: a type of area which links a denser city centre with peri-urban and rural areas, which has

now become common in countries in the Global North (Rodriguez-Pose, 2008). This means that outputs from this research could inform other areas which have a similar structure and are of a certain size, offering a level of transferability for this piece of work.

#### *3.2.4.1 Data sources*

Data was collected from the following sources:

- 2001 census,
- 2011 census,
- Consumer Data Research Centre and
- Data.gov.uk (open data owned by central government, local authorities, and public bodies).

All data collected was readily available publicly, and the only software used in the analysis and representation of information were Microsoft Excel and ArcGIS. Data extracted from these sources includes journey to work (origin-destination) information, geographical location of residences and employment locations (postcodes), and modes of travel to work used by commuters.

#### *3.2.4.2 Data analysis*

To better understand how MaaS might be structured in Greater Manchester, it was first essential to understand how city region residents and workers choose to undertake trips, the typical trip length, the trip origin, and the trip destination. Due to the data available, commuter trips were predominantly considered, with non-commuter trip assumptions made based on previous research conducted by TfGM and academic sources (Lawson et al., 2013; Silvestri et al, 2022). Transport route and transport mode use data for commuting trips was collected, evaluated, and analysed, to determine areas for potential MaaS patterns and therefore possible uptake.

As part of the analysis, the Greater Manchester Accessibility Level (GMAL) model was used to evaluate the gaps in public transport provision to district centres, the regional centre and Manchester Airport (included as a key transport hub and destination point in the city region). The steps undertaken in this work have been included in section 8.5 of chapter eight. The GMAL model uses postcode data to measure transport connectivity based on the services and distance to walk to reach the services (TfGM, 2021). This model was chosen specifically as it is currently used by Transport for Greater Manchester as part of their assessment process when considering areas for intervention and the potential interventions that could be undertaken.

## 3.3 Practicality of the approach taken

The approach taken in this research was informed by the philosophical underpinnings discussed above. However, as the concept of MaaS is relatively new in academic and professional circles the choice of methods and their ability to shed light whether MaaS could be developed in Greater Manchester was a critical consideration. As transport and urban planning are frequently intended to both inform future investments and have tangible outputs, this research was intended to provide additional depth to the debate on MaaS in Greater Manchester. Therefore the choice of methods, the use of the case study and the analysis undertaken result in recommendations to inform public policy and planning, as well as generating new knowledge that builds on existing academic debate and adds to identified knowledge gaps.

## 3.4 Chapter Conclusion

To conclude, this research uses case studies, existing data and new information gathered from primary sources to better understand the potential for a MaaS system in Greater Manchester, the areas which may be adopted more easily and the barrier points to adoption as well. The mixed methods approach, aligned to a philosophy of pragmatism, allowed for both breadth of information to be gathered and depth of information to be generated, resulting in insight into both MaaS as it's currently seen by professionals and academics, and the potential for a MaaS system to be developed in Greater Manchester. The next chapter will provide context for readers with regards to the topic of MaaS and MaaS trials conducted to date.

# 4 Chapter Four: Mobility as a Service: Context and Progress

This chapter offers additional context on how MaaS is treated in documents produced by consortia of local and transport authorities and will provide insight into some of the MaaS trials that have taken place to date around the world. The purpose of this chapter is to provide additional insight into MaaS as a concept and to consider how trials have been undertaken, as this is the only information source that includes practical application of some or all of the elements of MaaS. The ongoing challenges and the reasons MaaS trials have been unsustainable will be considered in this chapter. The section has been purposely split from the literature review, and it is not intended to critically review or evaluate the material, but instead to offer a short introduction to how MaaS is viewed by local and transport authorities, and to the types of trials that have already been attempted, where they took place and when. This section will also offer context in advance of the results sections (policy analysis, interview analysis and data analysis) to help the reader understand the position of MaaS development to date and which areas have taken a key interest.

To date, no sustainable MaaS system has been implemented at a significant scale in any country and publicised. No one area is the obvious leader of MaaS from a scale/performance perspective, but areas which have taken initial interest have been detailed in the following sub-sections. However, to better understand the potential impacts, along with attempts to devise a feasible commercial and business models, a number of consortiums have considered MaaS, and several trials have taken place.

## 4.1 MaaS and Policy Development

Several key actors in transport, both within the UK and globally, have commented in some way on MaaS. CIVITAS (2016), an independent research entity that aims to further public debate on key topics, considers MaaS to be a natural next stage for transport, citing technology developments as being the enabler for greater integration and personalisation of transport services. Alongside this, CIVITAS (2016) argue that the changing expectations of younger travellers, particularly in respect of a significant uptake in digital services, means that a paradigm shift in transport service provision is required. Having considered current trends, CIVITAS (2016, p.10) note the following seven trends they believe will become standard practice in the transport sector in the long-term:

1. "*MaaS will create a new model for how we buy travel: People will purchase travel using service contracts.*

2. *The transport sector will split…A distinction will emerge between customer-facing service businesses and the infrastructure and hardware providers supplying the capacity. Using the model of utility companies as an example, customers might have a monthly service contract with company A who may or may not be the actual provider of the service but is purchasing capacity separately from companies B, C and D.*
3. *More new business models: Car manufacturers' primary customers will be themselves, or subsidiaries and other partners, who provide car sharing schemes.*
4. *Actively managing the transport network and its price: The transport system will be more actively managed and dynamically priced based on demand, measured in real-time.*
5. *The of public vs. private transport: Rather than the current approach to urban mobility, that pits public and private transport against each other, car owners and users will be better connected and integrated with the whole transport system.*
6. *Joining different transport modes: The links between transport modes such as buses, trains or trams will blur as hybrid services cross the divides between them.*
7. *Greater cross-sector emphasis, recognising the wider role of transport: Transport will integrate with more aspects of people's lives and this will happen in two areas. Firstly, governments, cities and policymakers will better understand and use the links between improved transport and mobility opportunities and other areas such a better public health and supporting communities. Secondly, organisations and businesses will build partnerships to enable opportunities and benefits across sectors, such as local shops benefiting from their location next to a busy bus interchange."*

Whilst these points do not necessarily translate directly into a MaaS system, each trend highlights an area of the transport sector that is either evolving or needs to evolve to meet consumer demand. What is unclear from these trends is the level of input required from public sector bodies to indirectly bring about change, as opposed to what can be changed directly by market demand.

Similarly to CIVITAS, Polis (a network of European cities and regions working together to better understand and implement innovative transport solutions) (2017) has spent time investigating the potential benefits and implications of MaaS. In contrast to CIVITAS, Polis (2017) consider the risks of a purely commercial approach to MaaS, noting that this may result in higher costs for the user (depending on how commercial ownership would affect public subsidies) and a weakened relationship between the transport authority and the user. Polis (2017, p.8) goes on to note several key issues with MaaS at its current stage of development:

1. *"The role of the transport authority needs defining in the MaaS environment*
2. *The right public-private sector balance for transport service planning/booking/payment will be critical*
3. *Understanding the impact of MaaS on travel behaviour will be key to providing services that meet policy goals i.e. encouraging the uptake of more sustainable modes*
4. *Creating a system that provides the personalised approach that is often hailed as the key benefit of MaaS, along with delivering system benefits*
5. *Determining the best market environments for MaaS, including understanding the impacts of having multiple MaaS systems operating in one city/region*
6. *The business model and end "payer" in MaaS needs greater consideration*
7. *The long-term impact of MaaS on transport service procurement, particularly in areas with socially necessary services, needs greater exploration."*

These issues offer similar insight to those highlighted in the literature review chapter and demonstrate that both professional and academic questions relating to MaaS remain. In contrast, UITP (2019) (Union Internationale des Transports Publics or the International Association of Public Transport) offer a more positive perspective, considering the potential for MaaS to support a transition to more sustainable modes (and away from private vehicles). These examples represent either regional or global perspectives on MaaS, with each organisation noted offering a collaborative response based on consultation with their members.

## 4.2 Trials to date

A number of MaaS trials have taken place to date, each with their own modal components and payment and ticketing structure. Table 4, taken from the Netherlands Institute for Transport Policy Analysis (2018, p.10) highlights some of more well-known trials that have taken place.

As highlighted in the table, each trial has offered something slightly different and therefore each trial isn't directly comparable. The following sections will consider three trials in more detail: SMILE, UbiGo and NaviGoGo. These trials have been included as they each offer insight into a different type of MaaS trial.

**Table 4: An example group of the MaaS trials that have taken place to date. Source: Hensher et al, (2021); Netherlands Institute for Transport Policy Analysis (2018, 10); Wray (2019)**

| Name | Location | Year | Modes of transport |
|---|---|---|---|
| Business passes: NS Business Card, MobilityMixx, Radiuz, Total Mobility | Netherlands | 2013 | Car sharing, parking, fuel costs, e-car, charging, taxi, car rental, bicycle sharing, urban public transport, regional public transport |
| SHIFT | Las Vegas, US | 2013 | Bicycle sharing, car sharing, car rental, taxi, urban public transport |
| UbiGo | Gothenburg, Sweden | 2013 | Bicycle sharing, car sharing, car rental, taxi, urban public transport |
| Smile | Vienna, Austria | 2014 | Bicycle sharing, car sharing, taxi, urban public transport, regional public transport, parking |
| EMMA (TaM) | Montpellier, France | 2014 | Bicycle sharing, car sharing, urban public transport, parking |
| Hannovermobil | Hannover, Germany | 2014 | Car sharing, taxi, urban public transport, regional public transport |
| Moovel | Hamburg and Stuttgart, Germany | 2015 | Car sharing, taxi, urban public transport, regional public transport |
| myCicero | Italy | 2015 | Urban public transport, regional public transport, international public transport, parking, access to urban congestion charging zones |
| Tuup | Turku region, Finland | 2016 | Car sharing, bicycle sharing, taxi, urban public transport, Direct Rapid Transport |
| Whim | Helsinki, Finland | 2016 | Bicycle sharing, car sharing, car rental, taxi, urban public transport, regional public transport |
| Idpass | France | 2017 | Car rental, taxi, valet parking |
| NaviGoGo | Dundee and Northeast Fife | 2017 | Car sharing, taxi, urban public transport, regional public transport |

| Name | Location | Year | Modes of transport |
|---|---|---|---|
| | regions, Scotland, UK | | |
| WienMobil Lab | Vienna, Austria | 2017 | Bicycle sharing, car sharing, taxi, urban public transport, parking |
| KVV.mobil | Karlsruhe, Germany | 2017 | Bicycle rental, car sharing, urban public transport |
| TfGM MaaS trial | Manchester, UK | 2017 | Urban public transport, car sharing, taxi, bicycle sharing, on-demand ride sharing |
| Whim | Birmingham, UK | 2018 | Bicycle sharing, car sharing, car rental, taxi, urban public transport, regional public transport |
| SSB Flex | Stuttgart, Germany | 2018 | Urban public transport, ride sharing |
| FASTLinkDTLA | Los Angeles, United States | 2018 | Ride sharing/on-demand ride sharing |
| iMove Australia | Sydney, Australia | 2019 | Urban public transport, taxi, car sharing, car rental |

### 4.2.1 SMILE, Vienna

The SMILE trial took place in Vienna, between 8th May 2014 and 15th May 2015. Originally funded by the Climate and Energy fund and the Austrian Research Promotion Agency, over EUR7 million was invested in the back and front ends of the MaaS pilot (Audouin & Finger, 2019).

#### *4.2.1.1 Key components*

The project team included a mixture of transport providers, with both the Austrian Federal Railway company and Vienna's public transport provider taking leading roles in the development of the scheme. Alongside these partners, additional mobility providers included taxis, bike sharing, car sharing and charging points. Routing and information providers were also included in the consortium. Using a mixture of existing APIs and newly developed ones bespoke to the trial, the SMILE project aimed to offer users the ability to plan, book and pay for trips via a single application (Audouin & Finger, 2019). The application predominantly focused on travel within the metropolitan region of Vienna, but it also included the ability to book public transport in additional Austrian cities (Audouin & Finger, 2019).

Differing from other trials (notably the Whim offer in Helsinki), the SMILE project charged users a single monthly payment that was made up of all the services used during a one-month period (Audouin & Finger, 2019). In contrast, other projects have adopted a subscription service that offers a set amount of travel for different modes, often with a tiered system of access, with higher tiers usually offering greater access to modes and services (Karlsson et al., 2016; Utriainen and Pollanen, 2018).

#### *4.2.1.2 Trial outcomes*

The SMILE project ended in May 2015, due to a lack of ongoing funding and "divergences between the companies that had led it" (Audouin & Finger, 2019). During the trial over 1,000 members of the public tested the application and over EUR4,000 was spent on trips booked through the SMILE application (SMILE Mobility, 2015). During the trial, 48% of participants noted that their mobility behaviour had changed whilst using the application, but there was a lack of data relating to how the behaviour had changed. The ability to change behaviour (ranging from nudging to enforcing) is often cited as a potential benefit or drawback of MaaS, depending on the choices made by the traveller. Whilst no additional information was available, a quarter of participants noted their modal choice on daily trips had changed as part of their participation in the trial (SMILE Mobility, 2015).

### 4.2.2 UbiGo, Gothenburg

Reviewed by Karlsson et al. (2016), the UbiGo trial took place in Gothenburg Sweden between November 2013 and April 2014. The trial involved 195 customers in 83 households and offered a paid subscription service that used a simple credit system for users to access different modes.

#### *4.2.2.1 Key components*

The trial aimed to "bridge the gap" between public and private transport by creating a broker service on behalf of the user (Karlsson et al., 2016, p.3266). This included both standard and customised services that met user needs for different journeys. Aimed predominantly at households within the urban area, the trial relied on customers already having good access to different transport options, including public transport.

Using a mobile or web application, users could select a combination of possible services, each with a specific credit cost. Any subscription could be altered each month as well. The application was both the payment and ticketing portal, with pre-purchased and activated tickets being used through a smart device. During the trial one taxi company, one car hire company, one car share company, one bike hire/share company and one public transport authority were involved (Karlsson et al., 2016).

Karlsson et al. (2016) highlighted in their academic evaluation of the scheme the key components of the trial that the participants were offered, and that were unique to the trial itself:

- Customers were offered the option of not using their car at all throughout the trial. If the participants agreed to this, they were compensated economically. Twenty households agreed to this option;
- Customers used mobility credits, paid for by a subscription service. However, any unused credits were refunded to the customer;
- No nudging to sustainable modes or active travel was undertaken as part of the trial, with the only stimulation of using the service being three interviews throughout the trial in which they had to partake;
- A customer service available to users 24 hours each day, in an attempt to create a seamless experience in which UbiGo handled all paperwork and dealt with issues directly with the customer;
- The minimum subscription for the service was 1200 SEK each month, but Karlsson et al. (2016) note that the value of the subscription was 150% of the amount paid by the consumer.

#### *4.2.2.2 Trial outcomes and review*

The trial ended as planned in April 2014, with the intention to review the business model and possibly re-engage with customers again offering a sustainable system. However, it never returned due to the regulatory complications with a third-party business selling public transport tickets. As part of their review, Karlsson et al. (2016) considered a range of findings from the research conducted throughout the service and with the usage data shared upon completion of the trial. Most notably, the use of private cars was significantly lower than the trial operators or participants expected, with participants purchasing around 30% more hours in cars than what they actually used (Karlsson et al., 2016).

Alongside this, changes in both travel behaviour (over 60% over users changed how they travelled during the trial by testing new modes) and wider travel planning were noted, with customers considering which mode would be suitable for each journey instead of simply choosing the mode used most frequently (Karlsson et al., 2016). Upon completion of the trial, 97% of participants wanted to continue using the service.

### 4.2.3 NaviGoGo, Dundee and North-East Fife

Funded by Innovate UK, the NaviGoGo trial was the first MaaS trial in Scotland, running from October 2017 to March 2018. The trial itself included a pre-trial phase and an operational phase. During the pre-trial phase, 16-25-year-olds (the target audience of the MaaS trial) took part in a co-design process, to create a MaaS offering that would specifically meet their needs (ESP Group, no date).

The co-design workshop included a desk-based study into the perception of the young people in the target area of the transport offering available to them, including range of modes, accessibility, and affordability. A National Youth Team (NYT) was formed from volunteers and, unusually, this team were given equal weighting in the decision-making process for the trial (ESP Group, no date). Prior to the trial commencing, the NYT held multiple design sessions with young people, with an end result of a set of design specifications that were within the project constraints but considered user requirements at a greater depth than traditional transport planning.

#### *4.2.3.1 The service offering*

The NaviGoGo service offered a membership-based application available on smart devices and computers. The application offered users the option to plan, book and pay for rail, taxi or bike hire journeys using a balance stored in each user's account and the user, or parent/guardian, could top up this balance when needed.

ESP Group (no date, p.3), operators of the trial, incorporated the following key features into the application:

- *"A personalised journey planner with fare calculator responsive to a user's profile and entitlements*
- *A journey payment and fulfilment platform*
- *A forum for users; comments and feedback on transport options*
- *A "deal matcher" for intelligently matching individuals to deals and discounts*
- *A taxi splitter tool to simplify calculating the cost of a taxi journey with friends*
- *A "discover a destination" database containing local transport information*
- *Incentive points for positive/sustainable choice, delivered through Young Scot rewards."*

In addition to the above, weekly bus tickets could be loaded onto a user's Young Scots card during the trial.

#### *4.2.3.2 Trial results*

During the trial, over 2,000 journeys were planned and over 480 of those journeys were booked and undertaken (ESP Group, no date). In total, users spent over £3,500 via the application. However, each user was given £20 each month in their account as a starting balance and users could top up their balances as required on top of this.

#### *4.2.3.3 Policy impacts*

Beyond merely conducting a trial, the partners involved incorporated policy actions on the trial itself, to ensure the outcomes would be utilised beyond the trial's end. The policy considerations included supporting young people to choose sustainable modes and understand the variety of transport modes available to them, increasing participation in education, employment and leisure activities; and, making travel easier within the local areas (ESP Group, no date).

### 4.2.4 The Smart Mobility Challenge, Japan

In April 2019, Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLITT) launched the Smart Mobility Challenge: an effort to implement MaaS across multiple regions in Japan by improving several existing initiatives and launching pilot projects.

#### *4.2.4.1 The purpose of the Smart Mobility Challenge*

Several goals were established in advance of the Smart Mobility Challenge, by the MLITT (2019) in collaboration with other government agencies:

- Improving overall transportation, with additional focus on rural areas and areas with high volumes of tourism
- Ensuring effective use of existing public transport assets
- Noting the ageing society and declining demand, create an accessible and safe transport system.

The MLITT created a council of over 228 members to oversee the platform and share information. The council is made up of municipalities, private business and stakeholder groups. In order to deliver a MaaS system, the Smart Mobility Challenge programme focused on the following points for early development:

- Standardising data formats and creating rules for data use and integration
- Increase cashless payments and expand and enhance the subscription model for transport use

- Supporting collaborations between planning and development agencies, to enable new transport and infrastructure facilities to be created that offer new transport services for users
- Enable the uptake of new mobility services, including micro-mobility, on-demand public transport and autonomous mobility (MLITT, 2019).

### 4.2.5 The Smart Mobility Challenge: Deployment

Noting that different areas experience different challenges for different reasons, and require different solutions, the MLITT created regional "types" to categorise the issues, goals, and targets for different areas. Table 5 details the area types and goals to resolve local issues. In reflection of the area types, the MLITT invested over JPY300 million (out of a total budget of JPY3.1 billion) for MaaS pilots 19 areas across Japan. The 19 trials included 6 regional projects, 5 rural projects and 8 tourism related projects. These trials included the implementation of mobility apps, autonomous vehicle rapid transit, new ticketing and payments systems including private transportation on a fee-based system and a flat rate system for public transport (MLITT, 2019). Currently, this is the largest example of MaaS investment and piloting in one country across multiple area types.

#### *4.2.5.1 Trial results*

Several trials are currently underway or have now completed, with most commencing and completing in 2020. Key points of interest included:

- My Route MaaS app (developed and tested by Toyota, Nishitetsu and JR Kyushu) was downloaded over 30,000 times and offered Fukuoka city residents and visitors multi-modal trip planning and ticketing and payment options for taxis, buses (owned by Nishitetsu) and trains (operated by JR Kyushu)
- A MaaS application developed by Hitachi Ltd. for Hitachi City enabled journey planning across trains, buses, bus rapid transit, taxis, and walking
- The development of a subscription model of ticketing and payment for the Kyoto Prefecture, allowed users to pay JPY5,000 (around £35) to book rides on services offered by participating transportation operators.

Whilst the trial data is currently being analysed, the MLITT has launched the Smart Mobility Challenge 2, which will include over 50 demonstration areas, to maintain momentum. Within the 50+ demonstration areas, 38 businesses have been identified as expected to contribute to

the development of a MaaS solution that will support the resolution of regional transport challenges (Global Mass Transit, 2020).

**Table 5: Area types in the Smart Mobility Challenge programme. Source: Table created by author using data from MLITT (2020, no page number)**

| | Metropolitan area | Metropolitan suburban | Local Urban | Suburb/Depopulated area | Tourist destination |
|---|---|---|---|---|---|
| Current issues | • Lack of attention to diverse mobility needs.<br>• Lack of information about potential demand.<br>• Daily congestion | • Lack of first-/last-mile transportation services and connectivity<br>• Local congestion due to events, weather etc. | • Reliance on private cars<br>• Decrease in convenience and profitability of public transportation<br>• Insufficient transportation for the elderly and non-owner cars after returning their driver's licence | • Reliance on private cars<br>• Decline in local transportation<br>• Insufficient transportation for the elderly and non-owner cars after returning their driver's licence | • Lack of secondary transportation rural areas as well as tourism transportation<br>• Need to accommodate anticipated increase in movement of foreigners visiting Japan<br>• Need to regulate transport diversification to meet tourism needs and demand |
| Purpose of introduction | • Improve transportation convenience for all commuters<br>• Alleviate daily congestion | • Enhance first-/last-mile service<br>• Eliminate local congestion under specific conditions | • Improve condition of daily traffic regional revitalisation<br>• Encourage/support migration in the area | • Secure and maintain daily transportation<br>• Ensure transportation and logistics network in sparsely populated areas | • Improve tourist's travel experience<br>• Expand and improve tourism experience of foreigners visiting Japan |
| Implementation target | **MaaS**<br>• Coordination between MaaS<br>• Development of transportation nodes between various modes<br>• Consideration for universal design<br>• Provision of information in multiple languages<br>**New transportation service**<br>• Carpool taxi, ultra-compact mobility, share cycle etc. | **MaaS**<br>• Coordination with metropolitan MaaS<br>• Integration of core transport and first-/last-mile transport services<br>• Coordination with lifestyle services<br>• Provision of various payment and boarding confirmation procedures<br>**New transportation service**<br>• Car sharing, on-demand transportation, | **MaaS**<br>• Cooperation with other regional MaaS<br>• Creation of new transfer points<br>• Provision of flat-rate service in multi-transport mode<br>• Coordination with lifestyle services<br>• Provision of various payment and boarding confirmation procedures<br>**New transportation service**<br>• On-demand transportation, car sharing etc. | **MaaS**<br>• Cooperation with neighbouring MaaS etc.<br>• Integration of various transportation resources/modes in the region<br>• Coordination with lifestyle services<br>**New transportation service**<br>• Mixed passengers in depopulated areas, automated driving services centred on small points such as roadside stations etc. | **MaaS**<br>• Cooperation with MaaS, including airport access transportation and inter-city trunk transportation<br>• Integration with baggage delivery services<br>• Cooperation with tourism services etc.<br>**New transportation service**<br>• On-demand transportation, green slow mobility etc. |

| | Metropolitan area | Metropolitan suburban | Local Urban | Suburb/Depopulated area | Tourist destination |
|---|---|---|---|---|---|
| | | future autonomous driving service | | | |
| Direction of efforts | • Realisation of data linkage between various businesses<br>• Alignment with urban/transportation policies that aim for a sustainable society | • Alignment with urban/transportation policies that aim for a sustainable society | • Alignment with urban/transportation policies that aim for a sustainable society<br>• Cooperation/collaboration between transportation operators | • Realisation of sustainable from the perspective of residents<br>• Alignment with urban/transportation policies that aim for a sustainable society | • Sustainable cooperation and collaboration between businesses<br>• Realisation of MaaS interoperability in each region |

## 4.3 Chapter Conclusion

This chapter has offered a brief summary of some of the trials that have taken place around the world to date, along with a summary of MaaS policy and discussion pieces developed by network organisations that incorporate the opinions of city and transport authorities. As highlighted, many of the MaaS trials utilised a range of different modes and methods of engaging with potential users. This may be due to several reasons, including:

- Agreements in place with different transport services providers: challenges relating to commercial agreements with transport service providers were noted in chapter two;
- Funding provided to test MaaS scenarios: grant funding will typically be both time and scale limited, leading to decisions around what could and could not be included in a trial;
- A lack of agreed definition of MaaS: each area may be interpreting MaaS differently and as such may have designed and undertaken different trials.

Whilst the trials may have differed, this section has highlighted an interesting element that has resulted from each trial: participants have noted that during the trial their behaviour has changed (ESP Group, no date; Karlsson et al., 2016). This demonstrates MaaS may create an opportunity to change travel behaviour patterns. Understanding how these changes may form longer-term travel choices, and whether choices have reverted back to previous patterns after the trial ends, would require further investigation.

Alongside this, the intentions relating to creating a more ideal environment for MaaS to develop alongside launching several different pilots simultaneously gives insight into a new way in which policy makers are considering MaaS: by supporting and enabling several trials to happen simultaneously it allows local authorities and regional bodies to consider the different options relating to how MaaS might work and also whether different MaaS systems could exist in a space and interact with each other. This would be of interest in areas with several cities developing systems or noting an intent to develop systems, such as cities within the European Union which utilise cross boarder transport and cities within the UK. The next chapter provides the reader with context of the case study area, including its position within the United Kingdom geographically and its transport system.

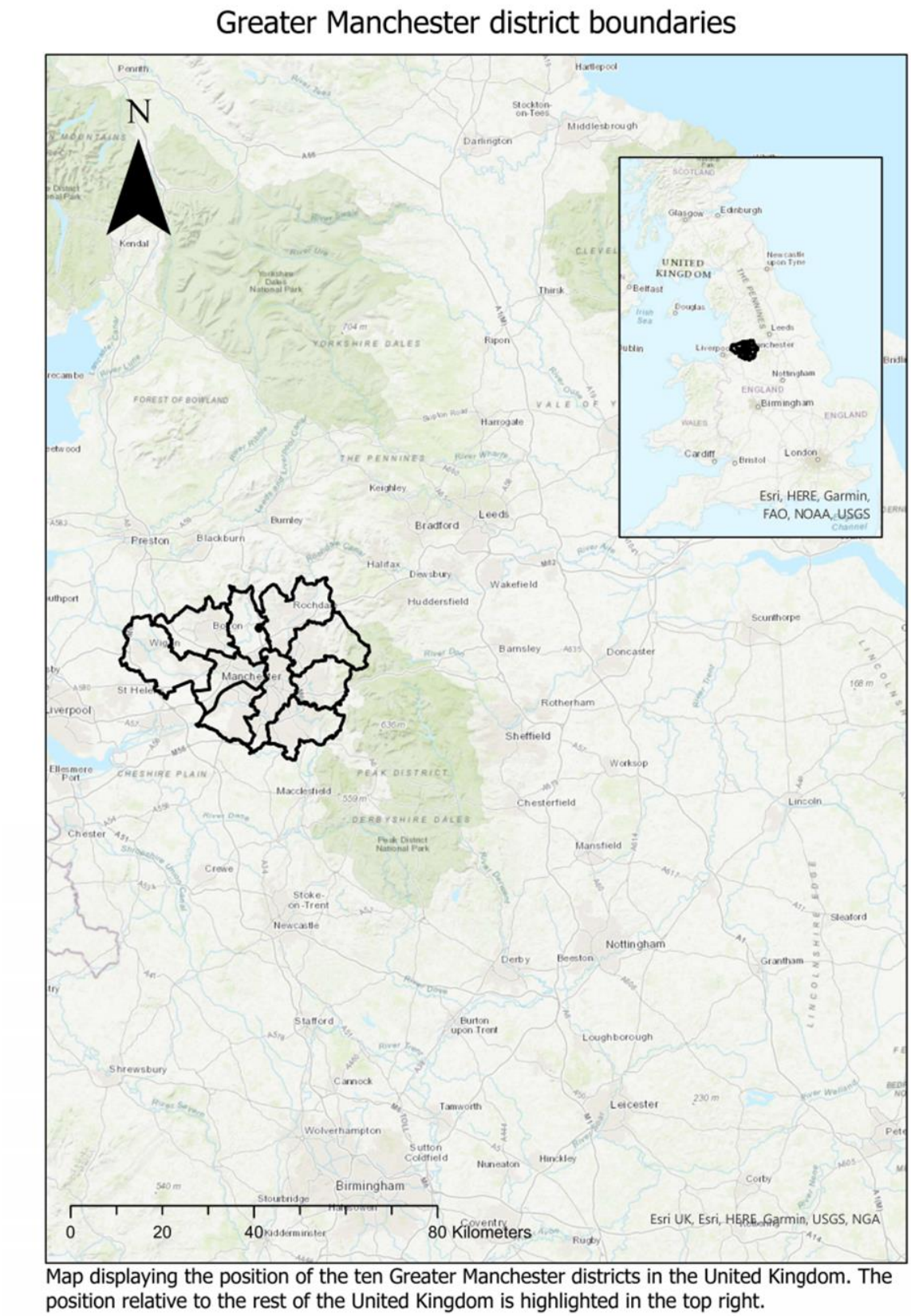
# 5 Chapter Five: Greater Manchester: a case study

This chapter provides context on the case study area of Greater Manchester. The complex nature of the city-region requires an explicit focus prior to the interview discussions, policy analysis and transport data chapters, to offer a grounding for the reader and to enable the reader to better understand the transport and governance landscape within the case study area. Devolution, transport funding, transport modes and transport innovation are all detailed in this chapter.

Greater Manchester is a city region and Combined Authority area in northwest England (see figure 5.1 for illustration of location). With a population in excess of 2.8 million, the city region consists of ten districts, two of which are cities and eight are Metropolitan Boroughs (TfGM, 2017). Figure 5.2 highlights the district boundary lines in Greater Manchester. At the heart of the 493 square miles is Manchester City Centre. This city centre forms the core of the central business district, with the regional centre comprising of this area and parts of Salford and Trafford.

With much of its wealth originally generated in the industrial revolution, Greater Manchester has now transitioned to the largest economy in the North of England, with economic output larger than that of Wales or Northern Ireland (MIDAS, no date). However, the city region also includes some of the most deprived areas in the country, with Manchester (5$^{th}$), Salford (16$^{th}$) and Rochdale (17$^{th}$) part of "the 20 local authority districts with the highest proportion of their neighbourhoods in the most deprived 10 per cent of neighbourhoods nationally on the Index of Multiple Deprivation 2015" (Department for Communities and Local Government, 15, 10). Figure 5.3 illustrates the areas in the city region by deprivation, with the darkest colour representing more deprived areas.

In recent years, the city region has adopted several new policies and initiatives that are aimed at pushing the city region in a more innovative direction, including the development and publication of a walking and cycling network, named the Bee Network framework (2018), the Greater Manchester Levelling Up Deal (Greater Manchester Combined Authority, 2021), and a target in Manchester to become a zero-carbon city by 2038, 12 years ahead of the 2050 national target (Manchester City Council, no date).




Map displaying the position of the ten Greater Manchester districts in the United Kingdom. The position relative to the rest of the United Kingdom is highlighted in the top right.

**Figure 5.1: Greater Manchester location in the United Kingdom. Source: Esri UK (2020)**


**Figure 5.2: Greater Manchester map highlighting district boundaries. Source: Greater Manchester Combined Authority (2021, p.36)**

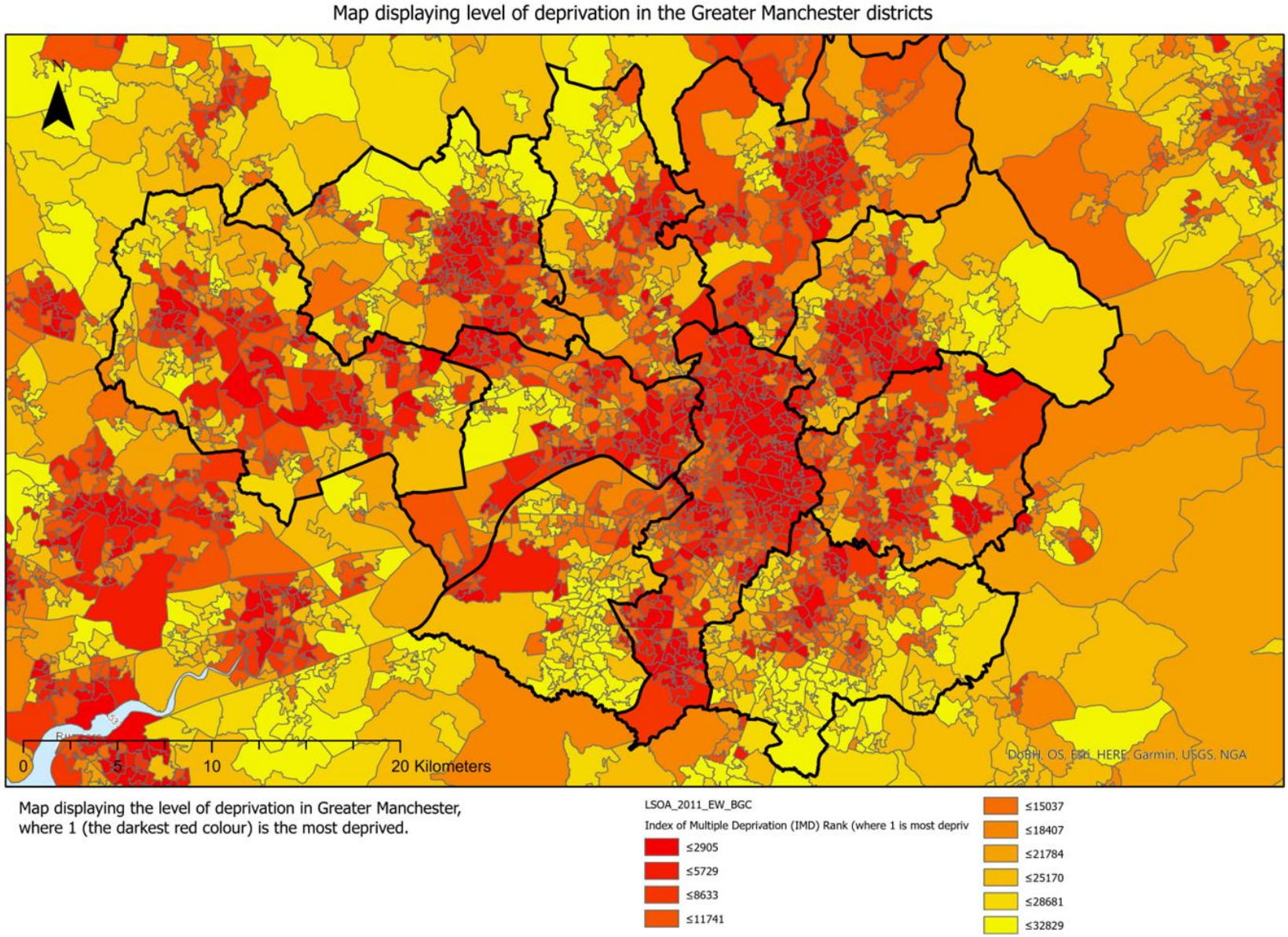



**Figure 5.3: Map of Greater Manchester showing areas of deprivation. Source: Ministry of Housing Communities and Local Government (2020)**

## 5.1 Devolution and Greater Manchester

City regions are a concept that have long been debated in the UK (Hodson et al., 2020). Offering the opportunity for competition at a regional level, city regions involve the devolution of agreed powers to regions, replacing the historical role of national government bodies in some areas (Hodson et al., 2020; Tomaney, 2016). Harrison and Hoyler (2014, p.2249) argue "…because of the relentless pace of change, these newly emerging metropolitan spaces are often reliant on inadequate urban-economic infrastructure and fragmented urban-regional planning and governance arrangements". Devolution allows systems to be restructured to meet local beliefs on how best to solve challenges. Tomaney (2016, p.546) argues there are five benefits of devolution:

1. *"Fiscal devolution will aid in rebalancing because this will create 'self-reliant cities' which prove to be 'more resilient'*
2. *Local government is more efficient than central government, as demonstrated by its ability to absorb public expenditure cuts*
3. *Devolution offers a way of invigorating local democracy*
4. *Devolved government will mean that SMEs will be able 'to plug into the public service supply chain'*
5. *Decentralisation will allow innovative approaches to be place-based and outcome-focused services."*

Greater Manchester is seen as a leader in city region devolution within the UK, having played a significant role in developing city region level systems and governance structures (Hodson et al., 2020). Given city region status in 2009, Greater Manchester established the Greater Manchester Combined Authority, made up of the ten districts within the city region, in 2011 (HM Treasury, 2009; Hodson et al., 2020). The reasoning for giving city region status to Greater Manchester related to intentions to rebalance the UK economy, specifically between the southern and northern areas (Hodson et al., 2020). The devolution of powers to Greater Manchester also enabled the creation and promotion of the Northern Powerhouse brand, in which Greater Manchester has a significant role (Hodson et al., 2020; Nurse, 2015).

The original City Deal (Greater Manchester Combined Authority, 2012, p.4) , agreed in 2012, gave the city region a set of decision-making powers, limited to:

- *"Create a revolving Infrastructure Fund by allowing Greater Manchester to 'earn back' a portion of additional tax revenue from GVA increases resulting from local investment in infrastructure*
- *Establish a Greater Manchester Investment Framework to align core economic development funds*
- *Create a City Apprenticeship and Skills Hub to place apprentices with SMEs, as well as piloting a skills tax incentive and locally determined outcome payments to providers*
- *Strengthen Greater Manchester's Business Growth Hub, which integrates trade, investment and businesses advice*
- *Develop Manchester's role as a beacon for high value inward investment*
- *Establish a Low Carbon Hub, with a plan to reduce emissions by 48% by 2020*
- *Establish a housing investment fund to use local and national investment to develop new housing*
- *Work with DfT on a broad package of transport proposals encompassing devolution of the Northern Rail franchise, bus improvement measures and devolution of local transport majors funding"*

These powers were expanded in 2014, and again in 2015, to include more transport planning, bus franchising, housing, and National Health Service spending in Greater Manchester. Alongside the expanding powers, it was also agreed that these powers would be controlled by a mayor for the city region (HM Treasury & Greater Manchester Combined Authority, 2014; Hodson et al., 2020). Whilst the total public spending for Greater Manchester is over £22 billion, the devolution deal was valued at more than £1 billion (Hodson et al., 2020).

## 5.2 Transport in Greater Manchester

Transport in Greater Manchester is overseen by TfGM (TfGM), the local transport authority, but transport services are predominantly operated by private businesses. The transport network in Greater Manchester is fragmented and complex, with confusion directly impacting a user's ability to navigate around the city region (TfGM, 2017/2021). This fragmentation is due to a range of issues, notably a lack of cohesion across services (with multiple companies competing on the same bus routes), complicated ticketing landscape (each bus and train operator typically offers their own ticket, which frequently cannot be used on another operator's service) and a lack of overall integration (as the trains and buses are run by separate companies, scheduling

does not complement each other to provide a seamless journey for passengers) (TfGM, 2017/2021).

Alongside issues with public transport, congestion on Greater Manchester roads is estimated to cost the city region £1.3 billion per year and contributes to tens of thousands of emissions related deaths each year (TfGM, 2017/2021). Recognising the long-term issues in the transport system, TfGM (2017/2021) published a strategy that identifies over 60 projects that will be completed within five years of its publication, and an intention to have over 50% of all daily trips made by public transport, cycling and walking by 2040. The sections below go into more detail on the funding for transport in the city region, along with the modes available for passengers.

### 5.2.1 Transport funding in Greater Manchester

Transport funding in Greater Manchester (similar to other areas in the UK) is split between the Transport Levy and Statutory Charge (Greater Manchester Combined Authority, 2020). The majority of this funding comes from the Greater Manchester districts. The funding from both sources is shared across the districts based on size of population. Table 6 shows the funding distribution in Greater Manchester, across the districts:

**Table 6: Details of the Transport Levy and Statutory Charge distribution per district for 2020/2021. Source: Greater Manchester Combined Authority (2019)**

| District | 2019/20 Transport levy £000 | 2020/21 Transport Levy £000 | 2020/21 Statutory Charge £000 | 2020/21 Total Charge £000 | Levy Change £000 | Levy Change % |
|---|---|---|---|---|---|---|
| Bolton | 19,587 | 10,732 | 8,797 | 19,529 | (58) | (0.03%) |
| Bury | 13,041 | 7,149 | 5,860 | 13,010 | (31) | (0.02%) |
| Manchester | 37,514 | 20,595 | 16,881 | 37,476 | (38) | (0.02%) |
| Oldham | 16,076 | 8,861 | 7,263 | 16,124 | 49 | 0.03% |
| Rochdale | 15,023 | 8,274 | 6,782 | 15,055 | 32 | 0.02% |
| Salford | 17,284 | 9,568 | 7,842 | 17,410 | 126 | 0.07% |
| Stockport | 20,015 | 10,973 | 8,994 | 19,967 | (48) | (0.02%) |
| Tameside | 15,413 | 8,469 | 6,942 | 15,411 | (2) | (0.00%) |
| Trafford | 16,195 | 8,889 | 7,286 | 16,176 | (19) | (0.01%) |
| Wigan | 22,326 | 12,263 | 10,052 | 22,315 | (11) | (0.01%) |
| **Total** | **192,473** | **105,773** | **86,700** | **192,473** | **0** | **0.00%** |

As highlighted in table 6, Manchester receives the largest amount of funding likely to due to the district containing the largest city in Greater Manchester. The following detail the different modes present in Greater Manchester and their role in the city region.

### 5.2.2 Heavy rail

Greater Manchester's rail network is one of the largest in any English city region (with over 263km of track) (Knowles, 1996). However, the ability of the rail network to be an effective mechanism for mass transit in Greater Manchester has always been hindered by the location of railway stations on the outskirts of the Central Business District as opposed to being centrally located within the centre, similar to other major cities (Knowles, 1996). Due to the built-up land and layout in the city centre, fragmentation exists between the key stations, resulting in poor connections between stations preventing efficient interchanging for passengers. Greater Manchester's rail network supported over twenty-five million trips annually before the COVID-19 pandemic (TfGM, 2017).

Heavy rail in the UK is operated under a national franchise system, which was originally put in place in 1996, having been authorised as part of the Railways Act in 1993 (Preston, 2016). As noted by Preston (2016, p.107), franchising "…involved a competition for the market based on bidding for subsidy or, in some cases, bidding in terms of premium payments". The intention for franchising was to allow private industry to improve the efficiencies of the heavy rail network and therefore reduce public subsidy over time, with the end result being services provided on a purely commercial basis (Preston, 2016). However, rail franchising in the north of England has had repeated issues due to ageing infrastructure and legacy rolling stock. In response to this, as of 1 March 2020 the UK government has taken over operation of the Northern franchise via an arms-length government owned company (Northern Trains Limited) (BBC, 2020). This decision was due to ongoing operational issues that included crowding and cancellations, with 1 in 14 trains cancelled in January 2020 (BBC, 2020).

### 5.2.3 Light rail (Metrolink)

Unlike other British cities, Greater Manchester has a light rail network of significant size. Having started investing in a light rail system in 1983, the Metrolink network now comprises of 99 stops along more than 100km of track (Cushing, 2016; TfGM, 2022). Figures 5.4 and Figure 5.5 highlight both the user map of stops and the geographical spread of the Metrolink network in Greater Manchester. Initial investment into the Metrolink light rail network was impacted by the deregulation of bus services as the impact of the light rail network competing

with bus services was considered in place of services being integrated with the light rail network. Unlike other transport systems in Western Europe and globally, Manchester's Metrolink was prevented from receiving any operating subsidy by central government. As such, the light rail network has to be operated, maintained, and expanded using ticket and advertising revenue, along with local funding. The Metrolink light rail network is operated by Keolis-Amey Metrolink (operations and maintenance are contracted out by TfGM on behalf of the Greater Manchester Combined Authority). Whilst the COVID-19 pandemic has meant lower passenger numbers in 2020/21, prior to this, over thirty-four million people travelled via Metrolink each year (TfGM, 2017). Following the COVID-19 pandemic, passenger numbers dipped to 40% of previous averages with passenger numbers now recovering around 70% of pre-COVID-19 numbers (TfGM, 2022).

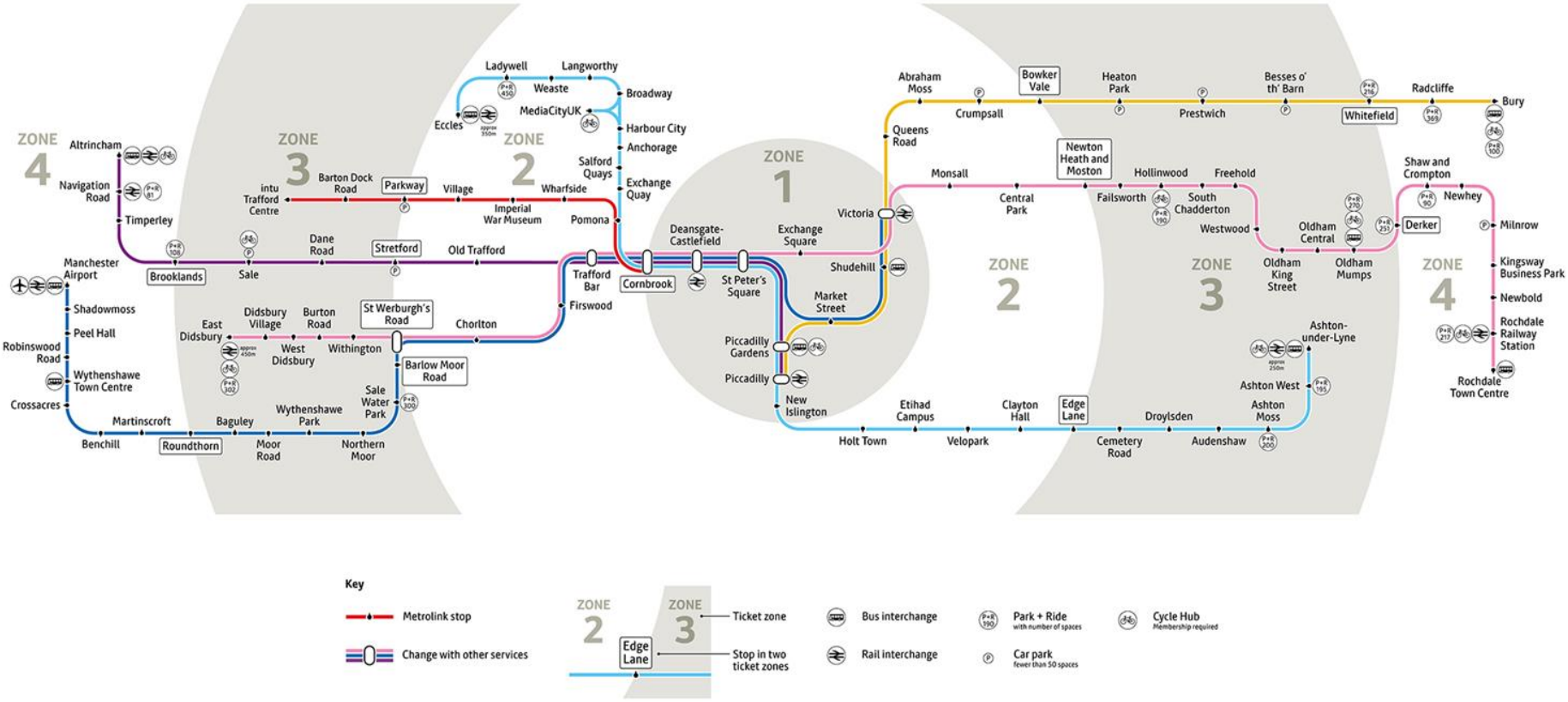



**Figure 5.4: User map of Metrolink light rail network. Source: TfGM (2020)**

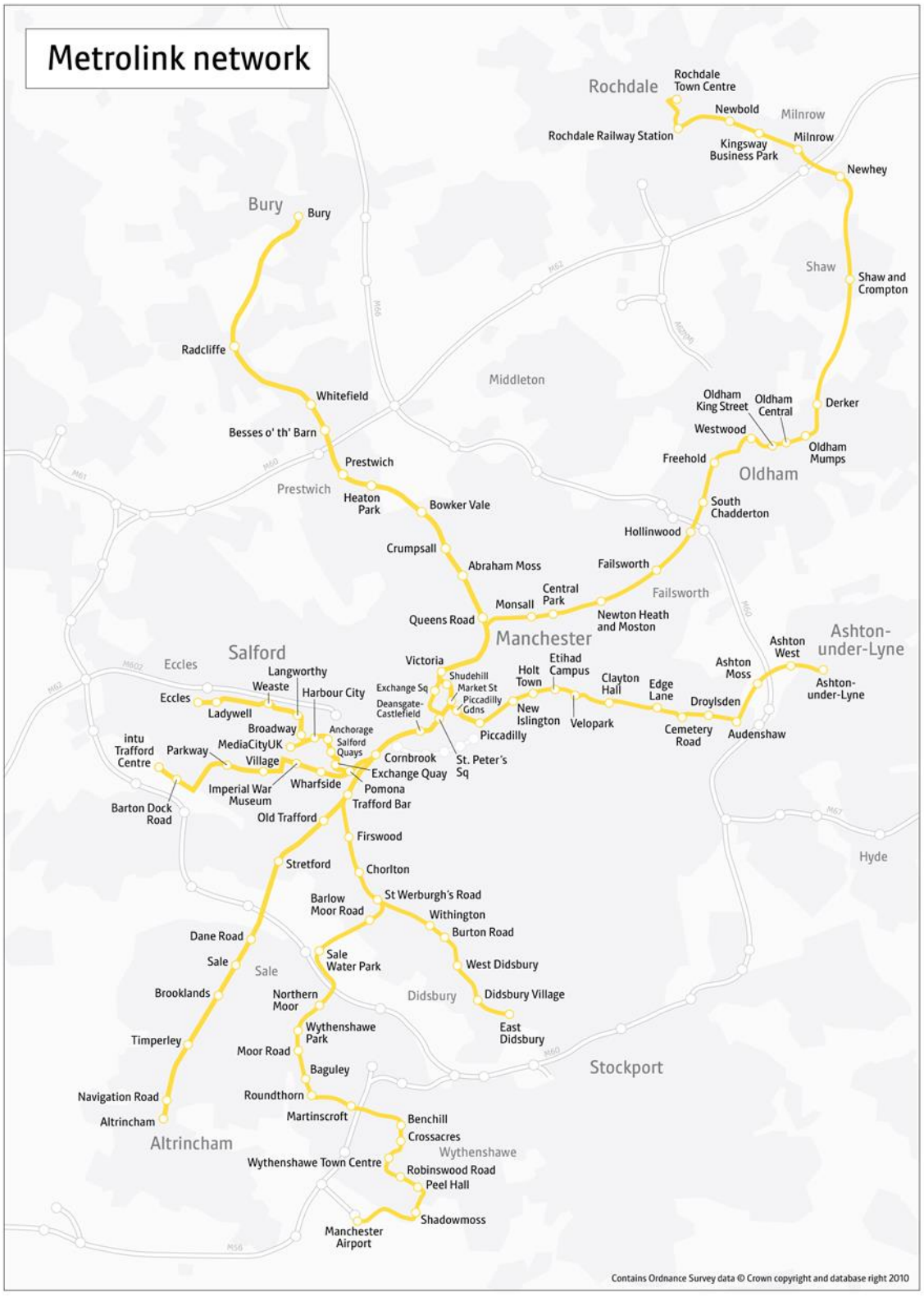



**Figure 5.5: Metrolink stops in geographical context in Greater Manchester. Source: TfGM (2020)**

### 5.2.4 Buses (commercial and subsidised)

The Greater Manchester bus network comprises of over 57 million miles, with over 186 million passengers using the services annually (Greater Manchester Combined Authority, 2019). Following the privatisation of the bus network in 1986, buses are operated by private businesses, although some routes are subsidised if they're considered socially and/or economically necessary. The network is operated by 39 operators, who offer over 573 services as of September 2022 (Greater Manchester Combined Authority, 2022). The physical assets, including bus stops and interchanges, are owned and maintained by TfGM. Currently, three out of four public transport journeys in the city region are undertaken using bus services (Greater Manchester Combined Authority, 2022). Figure 5.6 details performance levels from bus service users in Greater Manchester. Ongoing traffic in Manchester city centre has been noted as being a cause for declining punctuality, with operators developing their Automatic Vehicle Location (AVL) systems in an attempt to improve service planning (Greater Manchester Combined Authority, 2019).

Supported bus services (services deemed socially necessary but are unable to operate on a commercial basis) have been reduced by 20% in recent years (Greater Manchester Combined Authority, 2020). This reduction has been based on service reductions and improved efficiency savings, as opposed to the complete removal of services. Currently, just over 17% of mileage operated in Greater Manchester is subsidised, which costs almost £30m per year and includes school bus costs (TfGM, 2022).

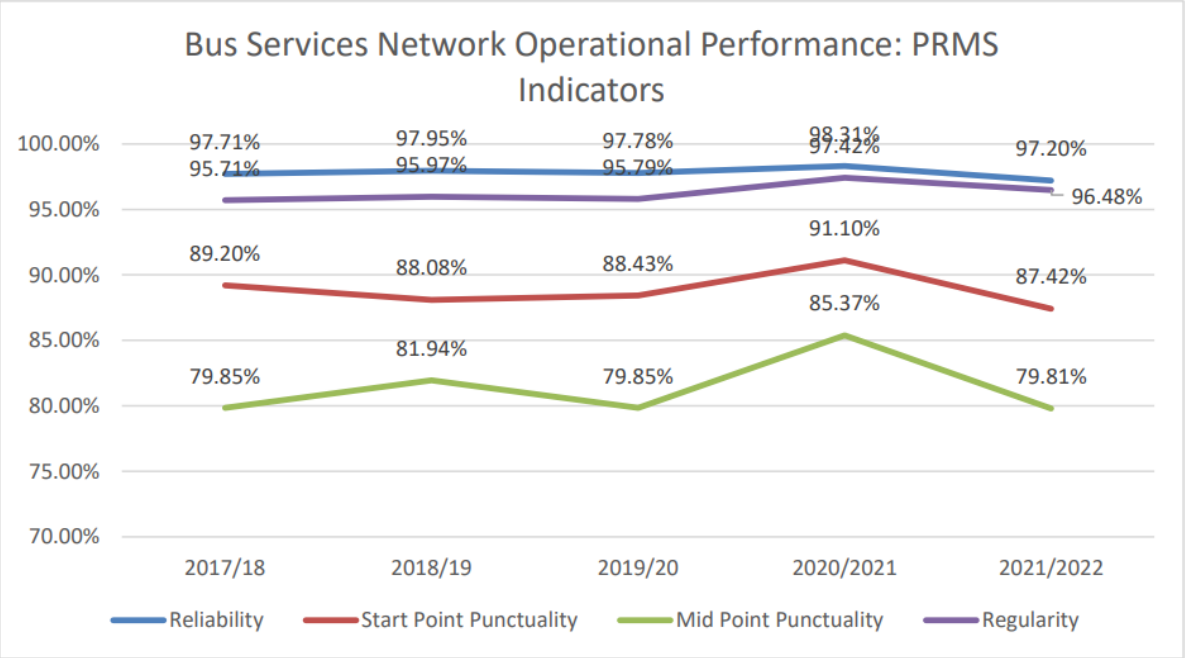


**Figure 5.6: Bus operational performance for bus services in Greater Manchester. Source: Greater Manchester Combined Authority (2022)**

#### 5.2.4.1 Bus Franchising in Greater Manchester

In 2017, the Greater Manchester Combined Authority tasked the local transport authority (TfGM) to undertake an assessment of the opportunity for a bus franchising scheme in the city region (Greater Manchester Combined Authority, 2022). This was able to happen due to the publication of the Bus Services Act in the same year. This new Act provides guidelines for bus franchising to areas outside of London, along with criteria which must be met to proceed. Following the assessment, in which 12,500 people responded, with over 80% of Greater Manchester respondents in favour of local franchising of bus services, the city region aims to proceed with the first franchised buses in place in 2023. This will be the first-time buses will have been operated through local control in over 36 years (Greater Manchester Combined Authority, 2022). Areas to receive the first franchised operations include Bolton, Wigan and some areas within Salford. The full network will operate on a franchised basis by early 2025 (Greater Manchester Combined Authority, 2022).

### 5.2.5 Highways/private vehicles

Car ownership on a large scale has resulted in congestion, both on key corridors and wider radial routes around the city region (Knowles, 1996; TfGM, 2017). This rise in congestion has been coupled with a rise in decentralised housing and employment locations in the city region, with leisure and shopping facilities now also facing additional separation (Knowles, 1996; TfGM, 2017). This process has facilitated a rise in car ownership, but Knowles (1996) argues that car ownership itself facilitated this rise as well.

Transport infrastructure to support movements via highways is highlighted in both the Greater Manchester 2040 Transport Strategy and the Greater Manchester Spatial Framework. Whilst the 2040 Transport Strategy highlights aspirations to create a sustainable city region with low transport emissions and equitable access to sustainable modes, this is in contrast to the Greater Manchester Spatial Framework which places residential, retail and employments areas that either aren’t served by public transport or poorly served by public transport.

## 5.3 On-demand transport services

Two types of demand responsive services are operated in Greater Manchester: Local Link and Ring and Ride. Local Link is a flexible transport mode that can be booked by anyone in Greater Manchester if they’re within the operational boundary, which can be seen in figure 5.7. To book Local Link, passengers can book online or by telephone up to seven days in advance of

travelling. The service picks individuals up from their homes and maintains a twenty-minute pick up window (ten minutes either side of a specified time).

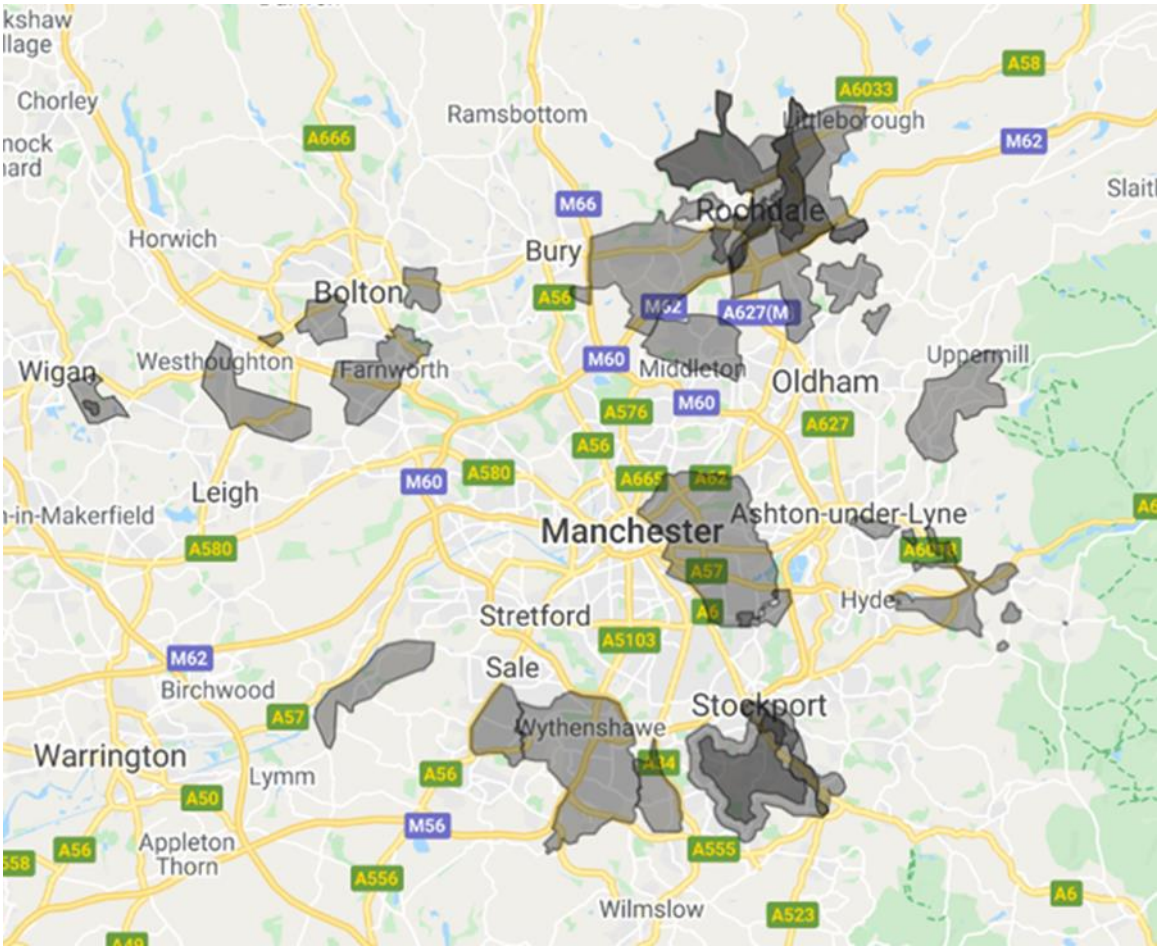



**Figure 5.7: Local Link operational area. Source (TfGM, 2020)**

Local Link is a legacy transport mode in the city region, with its services meant to fill gaps in public transport provision. However, it is operated on a subsidised basis as it cannot be operated commercially in its current form. It's 2019/20 budget was £2,335,000, however it only raised £294,000 in income. This service is one that is repeatedly mentioned in relation to the future of transport, as on-demand services are expected to become more popular. However, Local Link represents an ongoing issue with creating a commercially feasible on-demand service. In contrast to Local Link, Ring and Ride is a transport service that is only available to those who have additional mobility needs as a result of age or disability. To use Ring and Ride, passengers must have one of the following: a TfGM disabled person's travel pass, a disabled person's TfGM travel plus pass, be over the age of 70 (with or without a travel pass) or have difficulty walking, or have travel vouchers provided by TfGM for disabled people (TfGM, 2020). Ring and Ride trips can be booked up to a week in advance, but only by telephone. The service operates across the whole city region and is available to any resident that meets the criteria

previously stated. Both Local Link and Ring and Ride are minibus services that are operated by a procured contractor.

### 5.3.1 Cycling

Greater Manchester's vision for at least 50% of all trips to be made by sustainable modes by 2040 has been followed by recent investment and policy development to support an uptake in cycling in the city region (TfGM, 2017). Dubbed the "Beeline network", a cycling network for the city region has been created in collaboration with the ten city region districts. The expected cost of the new network is anticipated to be more than £1.5 billion and it will take over 10 years to deliver (Greater Manchester Combined Authority, 2020). Figure 5.8 highlights the intended bee network. As shown in figure 5.8, the final network is intended to comprise of over 75 miles of segregated cycling infrastructure.

#### *5.3.1.1 Bee Network developments*

Since its launch in 2017, the Bee Network has expanded to include a vision for a fully integrated public transport system, which will incorporate the existing Metrolink network, cycling and walking, rail and soon to be franchised buses in the city region (TfGM, 2022). This plan will be delivered in part due to the recent award of over £1 billion of central government funding which was awarded to the city region in April 2022 through the City Region Sustainable Transport Settlements (CRSTS) funding allocation (Marketing Stockport, 2022). This funding will be put towards integrating the Metrolink tram network with HS2 stations, repairing existing infrastructure, and funding active travel schemes (Marketing Stockport, 2022).

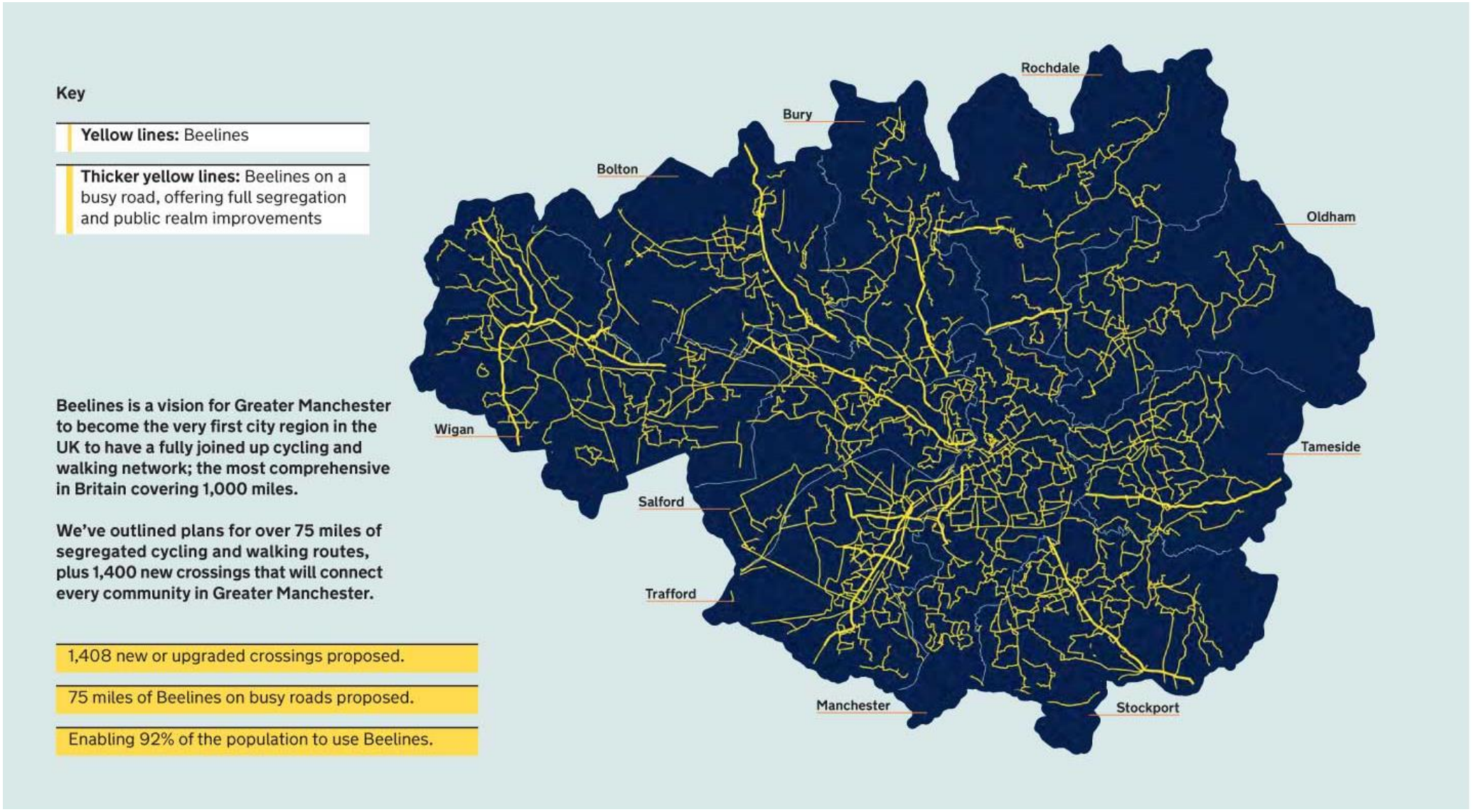



**Figure 5.8: The Greater Manchester Bee Network. Source: Greater Manchester Combined Authority (2020)**

### 5.3.2 Transport Innovation in Greater Manchester

Greater Manchester has adopted a proactive approach to innovation in transport (TfGM, 2017). The Greater Manchester Transport Strategy (2017, 8) states:

> *"We do not see innovation as an end in itself, but more a philosophy that we need to embrace, in a thoughtful and applied way, to everything that we do in transport over the coming year."*

This approach has resulted in the trial of new mode sharing options in the regional centre, including Mobike: a dockless bicycle sharing scheme tested in the regional centre in 2017. The following sections highlight some of the innovative programmes adopted by Greater Manchester

### 5.3.3 Mobike Trial

In 2017, Mobike chose Manchester to be the first city for trialling their dockless bike share scheme outside of Asia. Named, the "100th city", Manchester was the starting location in Europe, but other cities soon adopted similar schemes with Mobike and other providers (Pidd & Lavelle, 2017; Sherriff et al., 2020). During the trial, Greater Manchester visitors and residences used the bikes to make over 250,000 trips, which covered over 180,000 miles (Pidd, 2018). However, Mobike left the city after 17 months citing vandalism and theft as the main reason (Pidd, 2018). Over the length of the trial, Mobike stated that each month, 10% of the bike fleet were being vandalised or stolen (Pidd, 2018). Following Mobike's exit from the city region, TfGM has replaced the scheme with a publicly own bicycle hire scheme which offers residents and visitors access to 1,500 bicycles and 300 e-bikes since August 2022 (TfGM 2022).

### 5.3.4 Introduction of "Our Pass"

In September 2019, a new bus pass aimed at 16-18-year-olds was introduced across Greater Manchester. The pass allowed this demographic to travel for free on bus services in the city region, with the intention of enabling easier access to mobility, education and employment. The pass required a £10 administration fee, but also allowed users to purchase discounted Metrolink tickets. Over 33,000 passes have been issued to date, and over 50,000 journeys have been made using the passes (Greater Manchester Combined Authority, 2019).

### 5.3.5 Electric vehicle infrastructure

Alongside the modes above, infrastructure supports the use of electric vehicles (there are 150 dual-headed charging posts in the city region, offering 300 charging points). TfGM (2017)

acknowledges that whilst this network will need updating in future, there is an expectation that it will support the move away from petrol- and diesel-powered vehicles.

## 5.4 The UK, Greater Manchester, and the Levelling Up Agenda

Launched in 2022, following the inclusion of a Levelling Up political policy in the 2019 Conservative Party manifesto, the Levelling Up the United Kingdom White Paper sets out a vision for reducing disparity and creating more equality in relation to skill development, employment opportunities, and placemaking across the UK (HM Government, 2022,).

The Levelling Up Agenda aims to support devolution, by empowering local areas to create more productive, innovative, and prosperous towns and cities by better leveraging their "physical, human, intangible, financial, social and institutional capital", and by investing in each to inspire growth (HM Government, 2022, p.19). Many challenge areas are represented in this document, including transport infrastructure, with the White Paper noting:

> *"By 2030, local public transport connectivity across the country will be significantly closer to the standards of London, with improved services, simpler fares, and integrated ticketing."* (HM Government, 2022, p.17).

Alongside this, the White Paper notes the intention to improve digital connectivity across the country with a minimum standard of 4G available and 5G coverage to be made available in many locations by 2030 (HM Government, 2022, p.17). Both these elements are important in the context of MaaS: a MaaS system requires transport service and infrastructure integration and will likely rely on some form of digital connectivity to enable access for users. Improvements to both these areas will positively benefit Greater Manchester, particularly if the city region is able to mould the improvements to their transport network in a way that incorporates their local aims and goals for MaaS (this is analysed in more detail in chapter seven).

Investment towards the Levelling Up Agenda is being made available, with over £2.6 billion being made available via the Shared Prosperity Fund as an example (HM Government, 2022). Alongside this, additional devolution deals will be negotiated with city regions including Greater Manchester. In reflection of this, Greater Manchester set out an ambitious proposal that will utilise the funding available to create an integrated transport system (amongst other initiatives) and has received over £1 billion since 2021.

## 5.5 Chapter Conclusion

This chapter has summarised the city region of Greater Manchester, the current devolution programme, and the transport modes available in the city region. The purpose of this chapter was to provide background information on the current state of play in Greater Manchester, in advance of the research chapters. This enables the reader to be better informed in advance of the analysis and discussions drawn that will conclude with recommendations specific to the city region. As highlighted in this chapter, the city region has some elements of MaaS:

- A varied range of transport modes are available both in the regional centre and connecting to the districts and areas outside of the city region
- There is clear intent to better integrate the transport modes available
- There is an increasing use of digital technologies as part of the improvements to transport services

The existence of elements of MaaS may enable a system to be purposely developed and implemented, or the city region could take a similar approach to cities such as London, who have an integrated transport system without heavily engaging in the topic of MaaS. The following chapters highlight further how MaaS is being considered in the city region, including policy and strategic objectives that incorporate some of the transport modes noted in this section. Alongside this, gaps in transport service planning and provision are also noted in the research chapters and analysis on potential areas for MaaS implementation are considered.

The next three chapters detail the data gathered and analysis conducted, before the discussion chapter brings together insights in advance of the development of recommendations that will form the conclusion of this thesis.

# 6 Chapter Six: Engaging Key Actors around MaaS: Opportunities and Barriers to Upscaling

This chapter outlines the insights gathered in the semi-structured interviews conducted with a range of experts. The insights gained have added significant value and delivered information from the research conducted and professional experience in areas that either directly or indirectly relate to MaaS. The data collected and analysed contributed to the fulfilment of the first second and fifth research questions. Appendix A lists the interviews that have taken place. Alongside this, the insights gained informed the following research chapters, particularly the policy analysis which utilised key words identified in the semi-structured interviews. The interview participants were chosen, using a purposive sampling approach, specifically for their insight into either transport in Greater Manchester, MaaS or an industry/group that would be directly impacted by the implementation of MaaS and therefore could contribute towards the design of a system i.e. disability groups.

As per the methodology chapter, the interviews were semi-structured and included a loose set of guiding questions to encourage openness from the participants (Simons, 2009). Following the collection of the data, emerging concepts were identified and analysed using NVivo. The following section details the themes which emerged from the analysis of the data gathered.

## 6.1 Emerging themes

Figure 6.1 highlights some of the key themes that have emerged during the interviews. Each theme will be discussed in greater detail in its own section.

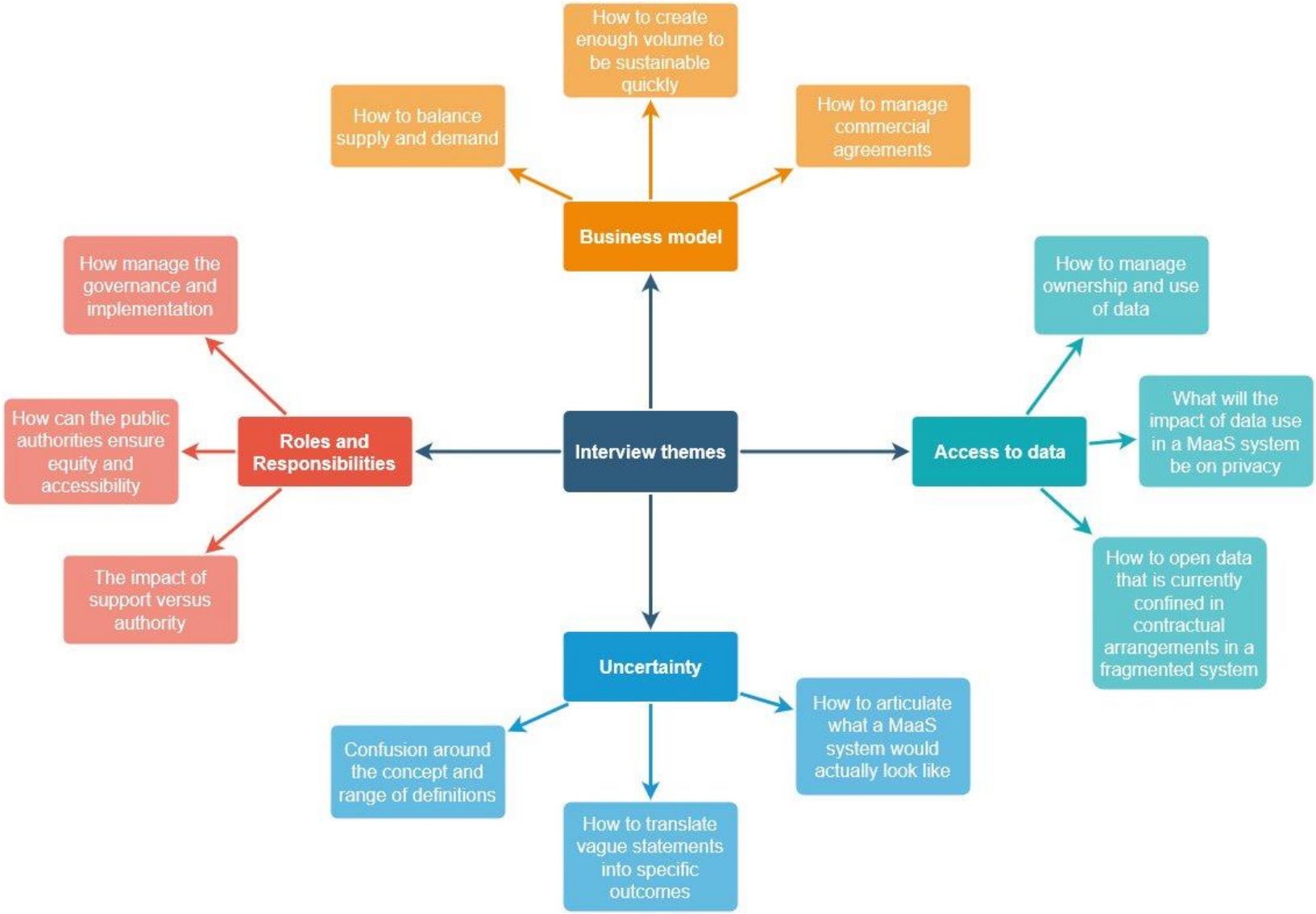



**Figure 6.1: Emerging themes from interviews conducted. Source: author**

### 6.1.1 Definition

The definition used by each participant differed and whilst there were components that mirrored each other, there was a lack of overall clarity. Additionally, not all participants to date have been aware of MaaS and could offer a definition. Table 8 includes the definitions or summaries used by each participant to describe MaaS.

**Table 8: MaaS definitions stated by interview participants. Source: author**

| Participant | Definition |
|---|---|
| Participant 3 | "For us it's the idea of taking information from all transport modes in a particular area and presenting it to the user in such a way as they make the most informed choice to get from a to b on that particular day at that particular time" |
| Participant 2 | "It essentially needs to be all encompassing (all modes, providing flexible options) and personalised (filtered to the individual's needs)" |
| Participant 14 | "It's giving members of the public a very simple way to access all their mobility needs. Simplest way is some kind of amalgamating platform that brings together all the different transport elements in their area, looks at how they can pay for them, looks at their personal preferences and tries to tailor a service to them. So if they're wanting to get from a to b and a bus can't get them from a to be, it might offer all the different ways and a price. There are lots of elements built into that, live features. I see it as a digital platform but there might be a different way of doing that" |
| Participant 7 | "A lot of people think it's just planning, booking and payment, but for us it's more |

| Participant | Definition |
| --- | --- |
| | than that, it's the trust, confidence and community that can come from MaaS" |
| Participant 8 | "…transport should be a lifestyle produce. It allows businesses and communities, it enables lifestyle, it has to give value to people" |
| Participant 4 | "So, mobility as a service, as we approach the concept, focuses a lot on the integration of different transport modes within a city or in inter-city context, so mobility as a service is about seamless mobility, door to door mobility" |
| Participant 1 | "So, there's what I view as full level 5… which is changing the world type stuff, full integration, central control of autonomous vehicles maybe, different pricing mechanisms…If you had to wait 15 – 20 minutes for a service, you might have to pay less. So true, final MaaS as I'm going to call it is all those things" |
| Participant 11 | "…it's always included an element of multi-modality, so bringing together information about different modes, journey planning by different modes, ideally enabling people to book and pay…So it's basically a platform for integrating things and providing a single front end for the users. Or in fact it could be multiple front ends, but the back end could be the same, so like a white label type thing." |
| Participant 6 | "For me it's people chasing technical solutions that don't address the problems." |

| Participant | Definition |
| --- | --- |
| Participant 16 | “it’s an integrator, its digital so it’s a digital way of integrating services to get people from A to B. Purporting or hoping to be as seamless as possible, so you deal with one service that effectively manages your mobility.” |
| Participant 17 | “it probably would be going towards sort of, full integration in terms of utilisation of app and mobile technology and a fully integrated transport system, almost like a seamless integrated transport system. Like a hub effect that everything went through, an interconnected transport network I'd probably say.” |
| Participant 10 | “it’s moving away from individual ownership of transport, like a car or even a bike, and towards the engagement of transport by paying a regular fee for a service that gets you where you need to go and gets you to what you need. That might be provided in different ways, so you might have access one day to a car share and one day to a transport, a public transport season ticket, on another day and they all fit together to provide transport as a service, rather than just owning a car and getting into it every time you want to go anywhere. I see that as the philosophy of it, and it tends to manifest itself in an app.” |
| Participant 15 | “As a term yes, it is new, but as a concept it’s an evolution instead, an important one in a much longing standing in the agenda of |

| Participant | Definition |
| --- | --- |
| | transport planning. It concerns improving the door-to-door journey experience for travellers, including improving the transport choices, the seamless and integrated experience of executing those journeys." |

The number of variations was specifically noted by several participants. Participant 12 argued that whilst MaaS is becoming more mainstream and a wider range of organisations and individuals are becoming aware of MaaS, the lack of a consistent interpretation of what MaaS is has made developing MaaS at a local level challenging.

Integration, personalised services and considering the full journey in place of just single modes were all mentioned or alluded to in the definitions. Multiple participants also stated what MaaS was not, with things such as single modes, individual brands and systems which incorporate only a few modes stated as being not true MaaS. Participant 6 also noted that the socially accepted position of private vehicles being more reliable and flexible than alternative modes was a mistaken belief by many, stating that cars are susceptible to journey time changes due to the volume of other users moving around the same area by the same mode. The intention to promote cars with a MaaS system was noted by participant 12 as being one of the initial challenges for MaaS whilst in its early conceptual development, with public transport and more active modes now being considered more frequently in the debate on suitable modes to be featured in a MaaS system.

### 6.1.2 Business models

The business model, including who defines and owns the model itself, was raised by several interviewees, highlighting potential areas of conflict with regards to ownership and use of data generated in the MaaS system. Clearly a key area of interest, each participant had varying ideas of both the key requirements and the challenges associated with defining either the business model or an option in a range of models. Overall, the participants agreed that no one has found the right business model to date.

> *"there are still discussions over how the business models would work, and I don't think anyone has really got answers to that yet."*
>
> ( Participant 3)

The lack of clarity around this area is a common theme when investigating MaaS and has also been raised by academics (Exposito-Izquierdo et al., 2017; Mulley et al., 2018). Interview participant 14 noted:

> *"…working for Stagecoach is actually understanding the business model behind it. What value is in it for the business is we're going to be sharing customers with competitors. I don't think it's quite cracked yet. We have examples of MaaS platforms that have a range of features, but its about getting the operators onboard"*
>
> (Participant 14)

The lack of evidence from operations means business models are being developed using only data from trials and the use of appraisal and modelling techniques:

> *"…because its data from market surveys and not actual demonstrations, we do not trust this data, we trust the data up to the point of what product are you going to purchase. We see with the products, for example, individuals always want to have public transport in their plans. Then when you go from the MaaS product to the travel behaviour and say ok I have purchased this product, and now how this product is going to affect my travel behaviour. Because it's a new concept and people do not know how it works, it is very difficult to trust this data because they do not know. That's why we are waiting for the demonstration in order to collect real preference data and model after the MaaS product what is the impact on travel behaviour."*
>
> (Participant 4)

Participant 12 concurred with this, arguing that even in funded MaaS projects, the outputs rarely translate to something meaningful beyond the life of the project. As such, their value in determining whether a system trialled in a project has contributed to the MaaS debate is limited. Participant 12 went on to argue that even in Finland:

> *"…where they have had legislation in place for more than two years, they changed their transport code and part of that was all mobility operators are opening up their ticketing system to enable MaaS to flourish let's say and what has been the impact there? You look at the size of the opportunity and it's still really, really small…"*

(Participant 12)

Similarly, participant 14 noted that whilst Stagecoach (a transport operator) is interested in the concept and has joined consortia developing and undertaking trials, they are taking a "watch and see" approach to how it develops, in place of a leading role. This highlights an ongoing challenge that MaaS faces in transitioning from an innovative concept that requires testing to an implemented sustainable system. Participant 8 and participant 7 noted that whilst significant time was spent on developing the business model for the Navi-Go-Go MaaS system, to enable it to be implemented permanently at scale once the trial had finished, the group was unable to agree on a model to support long-term operations. Alongside implementing MaaS at scale in urban areas, the business models for operating a MaaS system in more rural areas has also been raised as a challenge. Noting the need to offer a system of some sort to areas outside of high-density cities, rural business models would need additional consideration, with one interview participant believing that rural operations may never be a commercially viable option for a full MaaS system. Instead, MaaS could be used to improve efficiency and overall access to opportunities:

> *"I suspect there will be a rural project sitting out front, but it'll be looking at what… the solutions are that can improve the efficiencies. I don't personally believe it can be scaled and a money-making exercise. At best I think it's about improving efficiency and reducing the cost of these services. It's never going to generate any money in that sense. The focus is on creating, there will always be benefits of improving access to jobs and helping the local economy, but it will perhaps slow down the loss of young people who leave these areas. The services themselves need better access and improved efficiency."*

(Participant 3)

A similar concern regarding MaaS in rural areas was raised by participant 11, who noted that MaaS as it is currently described would unlikely be suitable in rural areas as public transport services are less prevalent. Instead, participant 11 noted that community and demand responsive transport services could be better utilised to offer a more appropriate version of MaaS that meets rural user needs:

> *"there's a long history of community transport providing, or demand responsive transport, and we almost need to re-learn that for Mobility as a Service and there needs to be more cross-sectoral cooperation in transport in rural areas. There's*

*actually quite a lot of provision through the school transport, health service transport for access to health care…different departments provide services. There's a lot that can be done with that, different community groups have minibuses for example which are probably just not used most of the time. I think there's potential for a Mobility as a Service product that will integrate all of that and use those assets more efficiently."*

(Participant 11)

Similarly, participant 8 noted that through the Pick and Mix project (resulting in the Navi-Go-Go trial highlighted in chapter four, section 4.2.3) new ideas were raised by the project volunteers that could offer a new opportunity around providing transport for the wider community:

*"if I could buy a coffee for £1.90 and it could be rounded up to £2 and the remaining amount could go into a community pot and someone going to an interview or something could get to it. A fantastic idea, but very technically complex"*

(Participant 8)

Alongside this, the Navi-Go-Go trial design volunteer group highlighted an ongoing challenge with regards to reconciling the vision of MaaS held by transport operators and the reality of what consumers want (participant 8). Participant 8 noted that a subscription model offering travellers a package of options with a monthly fee was rejected by the trial volunteer group in favour of an account that could be topped up by the user or a family member and used for individual trips. Participant 8 noted that the volunteer group was formed of young people, and therefore the needs they have may differ from the needs of other age ranges.

This highlighted that whilst the overall business models are being developed, MaaS could offer a new way of incorporating more inclusive and supportive policies around wider transport, and mobility support for the community is also provided. However, whilst the lack of clarity around business models prevents a scaled system from being implemented sustainably (with potential options ranging from public to private owned and operated systems), some actors in the MaaS space are still attempting to consider what the initial target markets will be, in an effort to make progress and move the conversation forwards.

*"In my opinion the larger target market will probably be mobile savvy younger users, however if you can lease a car for £100+ per month for complete flexibility, you may be reluctant to pay 3 times that for a MaaS service that may not currently, until more services are added, provide the same level of flexibility."*

(Participant 2)

Interest in business models was a recurring theme in the interviews, including the potential structures, what users would be included and who would own the overarching system. Participant 2 went on to discuss how the MaaS system could have a unique angle by offering a more personalised service than has previously been provided, which may attract users into trying the system. However, there was a lack of agreement across any of the participants, with each pointing to different options and potential impacts.

### 6.1.3 Roles and responsibilities

Whilst commercial public transport operations are typical in the UK, input into the design and operation of a transport network as a whole will be a new consideration in a MaaS system (Sochor & Stromberg, 2016). How this will work in practice, including who will manage or "own" different aspects of the system was of interest to all the interview participants. However, the views on how it would work in practice, including the assumptions made by the public and private sectors differed across participants.

*"Some operators are hoping the public sector will take a strong role as they can offer a level of transparency and equity where private operators…may be more commercially driven."*

(Participant 2)

The contrast in interest between the public and private sector is also noted in academic research with Karlsson, Sochor and Stromberg (2016) corroborating the idea that a public sector operator may retain a level of transparency and equity that a private business may be unable to demonstrate, and going on to say that the agreement in roles and responsibilities will impact everything from payments and ticketing to transport access and usage. This could be an area where a clear policy or set of policy objectives relating to MaaS could support the development of a system. As highlighted in chapter seven, many cities are not featuring MaaS in policy documents but may be considered trials. This presents a challenge for areas as they look to trial

how a MaaS system may work, whilst a MaaS system could likely be better defined with clear policies and guidelines provided during the design and development stage.

Interview participants identified several potential benefits of public sector involvement including the ability to nudge users into making sustainable choices and maintaining standards across the system as a whole. The use of nudge theory aims to encourage the development of new travel behaviours through the use of nudges towards new options available to travellers (McCarthy et al., 2016). However, the ability of a public sector organisation to play a large role in the organisation and operation of a MaaS system was questioned by multiple participants, with one noting:

> *"I thoroughly believe MaaS will be something that will come in, but I'm not sure what TfGM can offer because it's so data hungry, we no longer have any role as transport planners because Uber or whoever, its, they know a lot more about people's trips than people themselves, they're probably already predicting trips."*
>
> (Participant 1)

Corroborating this thought, another participant focused instead on the option of having a start-up who is not involved in the actual operation of transport prior to the MaaS system implementation, as a choice that will likely cause the least number of contractual and operational challenges:

> *"We have to have support from the public transport authority, but it seems the public transport authority is not the right organisation to be the MaaS operator. There are several other issues, for example fare competition standards. For a public transport authority, how are you going to decide how you're going to assign uber or Lyft. They offer the same services; they could both have a car next to the user. It's very difficult, there are a lot of issues for a public transport authority to solve, whereas for the private sector its easy."*
>
> (Participant 4)

This participant went on to state:

> *"That's why we conclude this that the best option to have other companies to be the MaaS operators, like a start-up, like for example we have in Budapest or even*

*here in London now we see that Citymapper have become a MaaS operator, they have started operating the weekly plans."*

(Participant 4)

This line of thinking was mirrored by another participant, who discussed the limitations of the public sector when it comes to being agile, particularly relating to contractual arrangements and procurement processes:

*"If public sectors are only involved in data governance, they might not have to worry about procurement. But if there's reasonable existing platforms, would it be easier to procure one?"*

(Participant 2)

Whilst there was lack of clarity around the wide range of input requirements for both public and private sectors, a number of participants felt the decisions on roles and responsibilities could be guided by and sped up, with guidance from a national body providing clarity on the expectations of a MaaS system and how the implementation should be handled:

*"I think the standards and guidelines should be provided from a higher level, instead of just the city level because if the city starts to provide this, then for example Manchester may have different standards from London and different transport systems"*

(Participant 4)

Alongside providing standards and guidance, one participant noted that a national body would also be able to consider the wider impact on users beyond just the economic case for implementation. However, when those local to the area were questioned specifically on TfGM's ability to play a key role, participant 6 and participant 1 both questioned the organisation's ability to be dynamic and entrepreneurial enough to be pivotal to the implementation of a MaaS system. In contrast, participant 5 noted that local authorities, who are also the highway authority in Greater Manchester, have a responsibility to consider wider infrastructure and how that can be used in achieving policy goals, recognising that transport services are only as good as the infrastructure they operate on/with. How this ownership and operation of infrastructure resources in the city region is managed may impact how MaaS develops and how successful it is, offering local bodies an additional element of leverage in a

MaaS system.

The lack of clarity around roles and responsibilities was noted as partially responsible for hindering progress in defining a MaaS system structure and ownership mechanism. Multiple projects were noted during the interviews, but all were conducted by either public authorities or businesses in isolation of each other, with very few having the range of possible actors represented in a consortium. This limits the amount of investigation that can be done into the potential impact of arrangements as evidence of collaborative trial successes and challenges is unavailable.

### 6.1.4 Access to data

Unsurprisingly, access to data and the system in which transport data can be used was raised as an area for additional work and one of key concern. Whilst some cities such as London have open data policies that have led to third parties providing useful applications for transport users i.e. Citymapper, other cities do not have control over transport usage data due to services being privatised and the data being owned and held by commercial bodies. Participant 14 highlighted that access to data is currently a key issue, particularly data that is held across different, privately owned transport operators. However, participant 14 goes on to note that without shared access to data, any MaaS system will be limited in terms of the features it could provide.

Interestingly, most of the participants named public sector bodies as those that should hold the overall responsibility for accessing data and using it in a way which would provide confidence to transport users regarding their privacy. Participant 3 agreed with this, stating that both local and regional governments could have roles to play in a MaaS system, particularly relating to the regulation and maintenance of the data platform.

However, as the UK public transport system is historically fragmented and generally operated on a commercial basis, access to data is defined contractually and therefore level of data access is not consistent across operators in an area. To access more or different data, additional agreements would be needed, and operators would need to understand what benefits they would get from agreeing to share the information. This consideration may need to happen in the short-term, with areas such as Greater Manchester now developing bus franchising models which will impact how buses are operated in the city region in future, and what data transport operators are able to retain and are required to share.

Two participants raised open data practices undertaken in other countries, with one discussing a new development in open data access: a mobility marketplace.

*"We've spoken with a New Zealand transport authority who have done this at a national level, and we've certainly made the Scottish government aware of that particular route. They have full visibility and control of it and can see that data and use it for all sorts of planning decisions. But also, it supports all the apps developers that can plug into it and the New Zealand transport authorities do have their own but they're happy for other to create their own."*

(Participant 3)

This option could offer flexibility for third parties, whilst allowing the regional or national government to retain control over usage and ensure any privacy considerations are met. Privacy around data usage was noted as a concern by one participant but they suggested that this was not a hindrance to pursuing a MaaS system, as many people already possess devices like smart phones that collect information and are not always clear on what is being collected or stored.

*"So technically a company like Google or Intel or whoever, the public trust, I don't think people care. Look how people treat their relationship with these companies over the last 15 years, it has changed massively, and people do it willingly or they perceive the benefits are greater than the cost and people really lap it up, they don't care. Like me, I claim I care about my location services but there's probably an option in there that I can turn it off. I don't think people care about their privacy, they're clambering over each other [to] post pictures of cakes and things."*

(Participant 1)

Whilst data privacy is of clear concern, along with who owns the rights to data and holds the ability to grant access, more thought on the impact of data usage to support a MaaS system is required. Without a higher level of understanding on how much personal and operational information would be required, including both historic and real-time data, those involved with designing, understanding and implementing a solution are prevented from fully considering this aspect. Additionally, when a MaaS system has been designed, the ability to communicate the data requirements to the public clearly and transparently will be essential to gain and maintain public trust, and to fulfil legal requirements regarding transparency of usage.

### 6.1.5 Uncertainty

Overall there was a clear theme running through all the interviews conducted: uncertainty. Uncertainty on what a future MaaS system would entail, how it would operate, what the

benefits will be and how to communicate those benefits to users effectively. Participant 6 questioned how such a system could exist when the gaps in provision currently are so large and scheme designs are not matching up to published policy encouraging a higher uptake of sustainable modes. Alongside this, similarly to what's been seen in academic research, the number of variables on what could be conceived to be a MaaS system is so high that those involved are limited in what they can or can't rule out or include. Participant 8 noted that when the Navi-Go-Go trial was in development, the technical teams were very apprehensive about the uncertainty around what the groups involved in the trial design were going to request and what could conceivably be delivered in the time frame with current policy and regulatory barriers. Similarly, participant 8 noted it was a challenge to help the Navi-Go-Go volunteer teams understand what was feasible to include in the trial. Alongside this, there is significant hesitancy to be the initial adopter:

> *"No one wants to be the Betamax or mini-disk of MaaS. It's something that's moving so fast and is quite difficult to avoid."*
>
> (Participant 3)

Whilst in many other innovations, such as smart ticketing, some cities were keen to be the first, with MaaS there is an expectation that the first will not necessarily be the best and that learning from the issues and challenges experienced by those that came before would be of clear benefit. Being second or third for implementation of a MaaS system was noted by more than one participant as being ideal. This is particularly the case if the definitions of MaaS differ greatly between different actors. Noted by participant 14, in his experience the definitions assumed by different actors within the MaaS space can lead to confusion around what the role of the system is and what the transport services should provide to users.

Participant 16 noted that it may be simpler to consider MaaS from the perspective of achieving levels of integration, digitisation, and access, in place of judging whether or not a MaaS system is fully developed and implemented in an area. This may reduce overall uncertainty and would also enable local and regional areas to consider what has been implemented elsewhere and to utilise best practice where possible. When considering this, participant 16 went on to note that Greater Manchester is already achieving some levels of MaaS due to the recent implementation of contactless ticketing and payments on the Metrolink light rail network.

### 6.1.6 Additional considerations

Whilst the sections above detailed the clearest themes presented in the interviews to date, two others were noted as being of interest during the analysis process.

#### *6.1.6.1 Model of MaaS*

The operational model of MaaS was raised by two participants and discussed at length. These discussions focused on the supply and demand mechanisms that would need to be considered and the ability of a MaaS system to optimise the modes available to meet the demand as and when it arises. If multiple modes are to be included and passengers have flexibility to choose between each, then the model of estimating and providing supply to meet the potentially fluctuating demand is a consideration for a MaaS system provider.

> *"We see this as something more, instead of just a user centric model. It involves both the supply and demand side and in order to optimise these you need more components"*
>
> (Participant 16)

How a MaaS model will be appraised and modelled, including the specificities required and the data needed for both was noted as concerns by both participants. The ability of individual organisations to consider the full MaaS model in data and evaluate whether it would be suitable was also noted as an area for additional work.

> *"So, we're in the game of trying to predict human behaviour, why is someone getting on bus as opposed to getting in car and vice versa. Economists make up all these weightings and costs and values of time to help us try and model why someone makes that decision. So, the policy talk now is about trying to make it more flexible, but that doesn't mean anything, an economist can't do anything with that."*
>
> (Participant 1)

Part of the issue relating to business model development is a lack of clarity around the specificities of a MaaS definition. This is turn leads to challenges appraising the impact of the model components, which prevents a thorough analysis of the costs and benefits, along with an evaluation on whether the business model would benefit a geographical area or group of people. Similarly, participant 8 noted that in MaaS trials, the trial itself may not be able to immediately impact existing service patterns and reliability, but the trial may inform service

providers and operators of potential areas for improvement through a trial operation of a new service pattern for a limited amount of time.

#### *6.1.6.2 The benefit of small-scale or short-term trials*

Small scale and short-term trials have frequently been used to test MaaS, generating data that could demonstrate the assumed benefits are accurate. A range of public and private funded trials have taken place to and continue to do so, in a number of locations globally. These trials have allowed transport authorities, service operators and users to test out a range of potential MaaS systems within set boundaries. However, participant 7 noted that not all ideas could be tested, with Navi-Go-Go volunteer groups raising heated bus stops as an option that could not be implemented within the boundaries of the trial itself. This raises interesting points around how MaaS trials could or could not trial wider improvements to the transport system that make modes more attractive but do not impact actual service delivery. The usefulness of these trials has been noted by those conducting them, however several questions have been raised about how much they've added to the development of the MaaS concept and whether they've answered any of the outstanding questions.

Participant 11 noted that the trials are frequently a complicated mix of actors and due to this, factual information can be difficult to extract and analyse away from the positive MaaS rhetoric. Participant 11 went on to note that the information is often shared in the MaaS networks and groups that are looking to forward the development of MaaS and add to the ecosystem, but this is not the same as making the data gathered open for analysis by those who are not involved in the network. This highlights that the MaaS concept is still being largely controlled by project consortia, lobbyists and groups looking to forward the MaaS idea, as opposed to those who may be involved in the day to day and strategic planning of specific regions or cities. Alongside this, participant 15 noted that:

> *"there's so few of them and they're so regimented in how they go about [it], it doesn't replicate the chaos that comes along with transport networks, particularly in the UK".*
>
> (Participant 15)

This insight provides a reminder that whilst trials may provide some information or small benefit, their ability to inform a large-scale change across a transport network is limited. Similarly, participant 16 argued that whilst trials have taken place locally in Greater Manchester, the data generated in the trials has yet to be incorporated into wider planning data

or made available to teams that would utilise it in the planning of the transport network locally. This highlights that whilst evidence of benefits is frequently cited as being missing, data generated through small-scale trials may be of limited value if not utilised by those planning and operating transport at a local or regional level.

#### *6.1.6.3 Designing a MaaS system*

When considering how a MaaS system could be designed, several parallels have been drawn with other sectors that have adopted a pay for access as opposed to ownership approach, including television and communications. Participant 15 argued that:

> *"…obviously the MaaS proposition draws parallels with the Netflix model and mobile phone contracts but in that, I'm not sure how readily translatable that is, in that other world it took some years for that type of model to come to fruition from pay as you go, pay per call, through to monthly tariffs which we all in."*
>
> (Participant 15)

Participant 15 went on to note that whilst it may have driven costs down in other sectors, there's very little margin for costs to be reduced in the transport sector, and that public subsidies would likely be required if this was the intention of a MaaS system. Taking an alternative view, interview participant 11 noted:

> *"I feel we need to push or get away from traditional demand forecasting and we should be more sensitive to the web of practices we have that shape how we do things. If we want things to be done differently, we need to take a different approach to how we plan, and that requires different approaches to visioning and actually setting transport within its social setting, the way we're articulating everything around, most of travel is a demand that's created around wanting to do something else"*
>
> (Participant 11)

By considering the initial purpose of travelling and the wider goals an area would like to achieve, a MaaS system could be designed to be more reflective of an area's vision for the future and how transport can play a role in delivering that vision. This was similarly highlighted by participant 8, who noted the original idea for the Pick and Mix project (and the Navi-Go-Go trial) was developed after realising the limitations of existing transport services that would

be able to replicate the freedom associated with car ownership and use for older people who needed to give up their car (in this case, the interview participants parents).

This was corroborated by participant 17 who argued that choosing to approach transport positively, instead of blaming car drivers or those who make choices which may negatively impact others, providing an alternative route that is both attractive and meets policy goals, for example replacing services with similarly reliable and responsive options, could offer more benefits in the long-term for both users and operators. Participant 8 and participant 7 noted that the co-design method utilised in the Pick and Mix project, which led to the Navi-Go-Go trial, led to the design of a system which was not anticipated by the project partners, highlighting the potential differences in opinion of what a transport system should provide and how it should be structured and accessed by transport planners and transport users. Participant 8 and participant_ went on to note that they were aware of other MaaS trials amending their systems, particularly ticketing and payments elements, due to a lack of interest and uptake by users. Similarly, participant 14 noted that MaaS could be a user-centred product and as such, input from potential users into the design and creation of a system would provide significant value at the early stages. This idea conflicts with traditional transport consultation styles, which frequently only ask for input from transport users towards the end of a design and development phase (Brown et al., 2021).

## 6.2 Chapter Conclusion

In total, over 20 recurring points relating to the challenges of implementing a MaaS system were identified from analysing the interview data. Alongside this, additional thoughts on the efforts conducted to date, organisations on the leading edge of MaaS implementation and the need for public awareness were highlighted as well. A clear outcome of the interviews was a lack of cohesion and clarity around what MaaS is and how it may work in practice. Without greater clarity, it appears unlikely that it can be implemented at scale without additional trials, including trials which provide insight in how not to operate and run a MaaS system. The next chapter will detail the insights gained through the critical policy analysis. Following this, the final research chapter analyses gaps in the Greater Manchester transport system and considers whether MaaS may offer opportunities at filling these gaps. Finally, chapter nine brings together the research insights and discusses them in relation to the case study area of Greater Manchester and chapter ten draws the thesis to a close, providing recommendations to policy makers and reflecting on the limitations of the work.

# 7 Chapter Seven: Policy Analysis

In the previous chapter, this piece of research has detailed insights gained from the semi-structured interviews. These insights play a key role in this chapter, offering keywords that formed part of the thematic analysis. This chapter details the policy analysis conducted on the relevant Greater Manchester documents and additional policy and planning documents. The chapter includes regional and international policies and offers a background to primary data collection.

Facing increasingly challenging long-term considerations, that have also increased in complexity and impact, public policy makers are being increasingly required to create visions and narratives that incorporate or consider societal change or transition (Howlett, 2014; Miedzinski, 2018). Understanding these policy narratives is critical, to better reflect on how data of trends today are used to support future scenarios and visions (Miedzinski 2018). Optimistically, policy design has often been aligned with politicians and policy makers taking the opportunity to consider the "art of the possible", but policy design also enables powerful actors to use instruments available to best obtain their goals (Howlett, 2014, p.194). However, as decision-making becomes more complex the ability to offer solutions becomes more difficult, with policymakers instead relying on high-level goals supported by little detail that offers clarity on positions on key topics such as climate change (Marsden & Reardon, 2017).

Diercks et al. (2019, p.887) state that policy documents are "the outcome of a political process…[and are] a manifestation of multiple and competing sets of discourses". Howlett (2014) concurs with this idea but goes on to argue that policy documents reflect the circumstance and area, whether it's a situational decision that is considered irrational or if it's designed after careful consideration of data and evidence.

The purpose of this chapter is to identify whether the policy conditions exist to support the development and implementation of a MaaS system. Whilst specific requirements for a MaaS system are disputed amongst professionals and academics (as noted in chapter two), some general components have been identified as potential themes that would support the development of a system. Where MaaS was not directly mentioned in the documents, the key themes of a MaaS system were identified using a coding framework (explained below in Section 7.4). This insight supports the critical evaluation of whether Greater Manchester is intending to develop elements that may support the implementation of a MaaS system (based on public policies published) and where it differs from other cities which are frequently

considered to be innovative. The chapter will conclude by setting the stage for the final results chapter (chapter eight) and the discussion chapter (chapter nine), which will compare the 2040 Strategy with the other documents reviewed, to better understand where innovations are utilised and what aspects of an innovative city region are missing which could impact the development and implementation of a MaaS system.

This chapter is divided into six sections:

- A summary of the documents analysed
- A background on transport policies and their development in the United Kingdom, to add context on how the 2040 Transport Strategy has been developed and why
- A content evaluation of the 2040 Transport Strategy
- A thematic analysis of the 2040 Transport Strategy
- A thematic analysis of the Greater Manchester Strategy
- A thematic analysis of the additional policies from innovative cities.

This approach has been chosen as it could be replicated elsewhere, for other cities and region regions. This offers a level of repeatability and transferability for the methods used and the insights gained from the results.

## 7.1 Policy documents analysed

In total, 77 policies were reviewed, including the 2017 and 2021 versions of the 2040 Transport Strategy for Greater Manchester, the Greater Manchester Strategy and 74 policy and planning documents from other cities (see table 9 for the full list). The additional policy documents were chosen from the Innovation Cities Index (part of the Innovation Cities programme), with data prepared by an analysis consultancy, 2ThinkNow (2019). Greater Manchester features on the Innovative Cities list at number 57 (2ThinkNow, 2019). In comparison to other European cities, Manchester is ranked 18$^{th}$ out of 165, with only London higher up in the rankings for the UK (in the 1$^{st}$ position) (2ThinkNow, 2019).

The top 30 cities were chosen, and the transport and urban planning strategies were reviewed, as these documents were noted as able to provide an insight into the future intentions of public bodies and transport authorities. Table 9 details the cities chosen, along with documents analysed. The cities represent a broad range of sizes and types, with cities of a similar size to Greater Manchester included along with megacities and those who represent cities going through rapid growth.

### 7.1.1 Sourcing policy and planning documents

To find the policies, the following key words were used: *Transport strategy, transport plan, mobility strategy, mobility plan, urban strategy, city strategy, urban growth strategy, urban plan, city plan, urban masterplan, city masterplan.* Only policies in English were reviewed and table 9 lists reasons for any cities where policies were missing or unavailable. The cities are also all from the global North. This is as a result of their position in the indexing and was not chosen by the author.

**Table 9: Table of top 30 innovative cities in the world. Source: created using material from 2ThinkNow (2019)**

| City | Innovation ranking | Document 1 analysed | Document 2 analysed | Document 3 analysed (if appropriate) | Reason if not included |
|---|---|---|---|---|---|
| New York | 1 | New York State's Transportation Masterplan for 2030 | One NYC 2050 | | |
| Tokyo | 2 | New Tokyo. New Tomorrow. Action Plan. | Tokyo city strategy | | |
| London | 3 | Mayor's Transport Strategy | London Environment Strategy | The London Plan: Spatial Strategy | |
| Los Angeles | 4 | Los Angeles Mobility Plan 2035 | Metro Vision: a strategic plan for 2018-2028 | | |
| Singapore | 5 | Singapore land transport masterplan 2040 | Singapore smart nation executive strategy | | The full smart nation plan could not be found |
| Paris | 6 | Paris urban mobility plan (key elements) | Paris smart and sustainable plan | | Full urban mobility plan could not be found in English |

| City | Innovation ranking | Document 1 analysed | Document 2 analysed | Document 3 analysed (if appropriate) | Reason if not included |
|---|---|---|---|---|---|
| Chicago | 7 | Roadmap for the future of transportation and mobility in Chicago | Chicago General Area Plan | Chicago's Global Strategy | |
| Boston | 8 | Go Boston 2030: Imagining our transportation future | Housing a changing city: Boston 2030 | Imagine Boston 2030: a plan for the future of Boston | |
| San Francisco | 9 | San Francisco Municipal Transportation Agency Strategic Plan | San Francisco's transportation sector climate action strategy | | City plan could not be found |
| Toronto | 10 | Get Toronto Moving | Toronto: collaborating for competitiveness | Climate Action for a Healthy, Equitable and Prosperous Toronto | |
| Melbourne | 11 | Melbourne Transport Strategy 2030 | Melbourne 2030: Planning for sustainable growth | | |
| Berlin | 12 | Berlin Urban Development Concept: Berlin 2030 | Smart city strategy Berlin | | |

| City | Innovation ranking | Document 1 analysed | Document 2 analysed | Document 3 analysed (if appropriate) | Reason if not included |
|---|---|---|---|---|---|
| Dallas-Fort Worth | 13 | Metropolitan transportation plan for the Dallas-Fort Worth Metropolitan area | Connect Dallas: Strategic Mobility Plan Scenario Guide | Forward Dallas! Comprehensive Plan Vision | |
| Seoul | 14 | 2030 Seoul Plan | | | Transport plan could not be found |
| Sydney | 15 | Sydney future transport strategy 2056 | Sustainable Sydney 2030 | | |
| Seattle | 16 | Seattle transit master plan | Move Seattle: strategic vision for transportation | | |
| Houston | 17 | Plan Houston | | | No additional plans could be found |
| Atlanta | 18 | Downtown Atlanta Master Plan | Atlanta's transportation plan: final report | | |
| Washington D.C | 19 | The District of Columbia's Multimodal Long-Range Transportation Plan | A vision for growing an inclusive city | | |

| City | Innovation ranking | Document 1 analysed | Document 2 analysed | Document 3 analysed (if appropriate) | Reason if not included |
|---|---|---|---|---|---|
| Miami | 20 | City of Miami comprehensive neighbourhood master plan: transportation element data inventory and analysis | Miami comprehensive neighbourhood plan goals, objectives and policies | | |
| Barcelona | 21 | Circular economy in Barcelona metropolitan area | Montreal resilient city strategy | | Urban mobility plan in Spanish only |
| Montreal | 22 | Montreal adopts its vision of the future with the Masterplan | | | Mobility plan only available in French |
| San Diego | 23 | 2020-2025 strategic plan | San Diego Forward: 2019 federal regional transportation plan | San Diego climate action plan | |
| Philadelphia | 24 | Connect: Philadelphia's strategic transportation plan | Growing with equity: Philadelphia's | | |

| City | Innovation ranking | Document 1 analysed | Document 2 analysed | Document 3 analysed (if appropriate) | Reason if not included |
|---|---|---|---|---|---|
| | | | vision for inclusive growth | | |
| Vienna | 25 | Vienna Urban Mobility Plan | Vienna Urban development plan | | |
| Beijing | 26 | | | | City and transport plans unavailable in English |
| Munich | 27 | Transport Development Plan | Projects, Planning and Prospects work report | | |
| Madrid | 28 | | | | Urban and Urban Mobility Plans unavailable in English |
| Milan | 29 | Regional programme for mobility and transport | | | City plan unavailable |
| Amsterdam | 30 | Amsterdam structural plan | | | City and transport plans unavailable |

## 7.2 Transport policies in the United Kingdom: background

This section provides a background to the development of a Local Transport Plan, to offer context to why the 2040 Strategy was developed in Greater Manchester. Transport policies in the UK are developed in a number of different ways, depending on the area, with some regions having devolved or partially devolved responsibilities (Bloyce & White, 2018). In some areas policies are the responsibility of city region mayors whilst in other areas the responsibility lies with the Local Authorities (Bloyce & White, 2018). The responsibility for preparing a plan differs depending on the local political context and could include councils, transport authorities and city region authorities. The following section highlights how transport policies in Greater Manchester are specifically developed.

### 7.2.1 The 2017 Greater Manchester Transport Strategy

Transport policies in Greater Manchester are set out and agreed across ten unique districts (as highlighted in figure 5.2 of chapter five), all of which may have slightly differing intentions or perceptions on the best way to achieve the long-term city region goals (which will also have been agreed at city region level) (Howlett, 2014). The differences in population demographics, economic prosperity, labour markets and access to education will impact the transport policies of each district, which will then go on to shape the wider city region policies.

Traditionally, each district contributed resources and expertise in the development of a Local Transport Plan. The Local Transport Plan (LTP) is a statutory document that sets out the transport objectives, policies, and strategies for an area. The requirement to develop and maintain a LTP was included within the Transport Act 2000 (HM Government, 2000). Within this document, an area will reflect on previous developments, future funding, and intentions for the funding to be utilised in certain ways.

However, due to the unique nature of the city region and its responsibility for transport being devolved to the mayor, TfGM prepared and published the Greater Manchester 2040 Transport Strategy (2040 Strategy) in 2017 and updated it in 2021 on behalf of, and in consultation with, the ten districts. This top-down approach to policy development has incorporated the requirements of the districts framed from the wider perspective of the city region (McTigue et al., 2018).

The 2040 Strategy has been agreed and adopted by the Greater Manchester Combined Authority and represents a policy vision for the city region. Accompanying the 2040 Strategy is a delivery plan that offers detail on the schemes to be implemented. These schemes are

believed by TfGM and the ten districts to be actions that will enable the city region to reach the goals established in the 2040 Strategy.

The 2040 Strategy is the main strategic transport document for the city region and offers a high-level view of goals and targets for the city region up to the year 2040 (and in some cases, beyond). Figure 7.1 articulates the key components of the vision for transport in Greater Manchester by 2040 (TfGM, 2021, p.7).

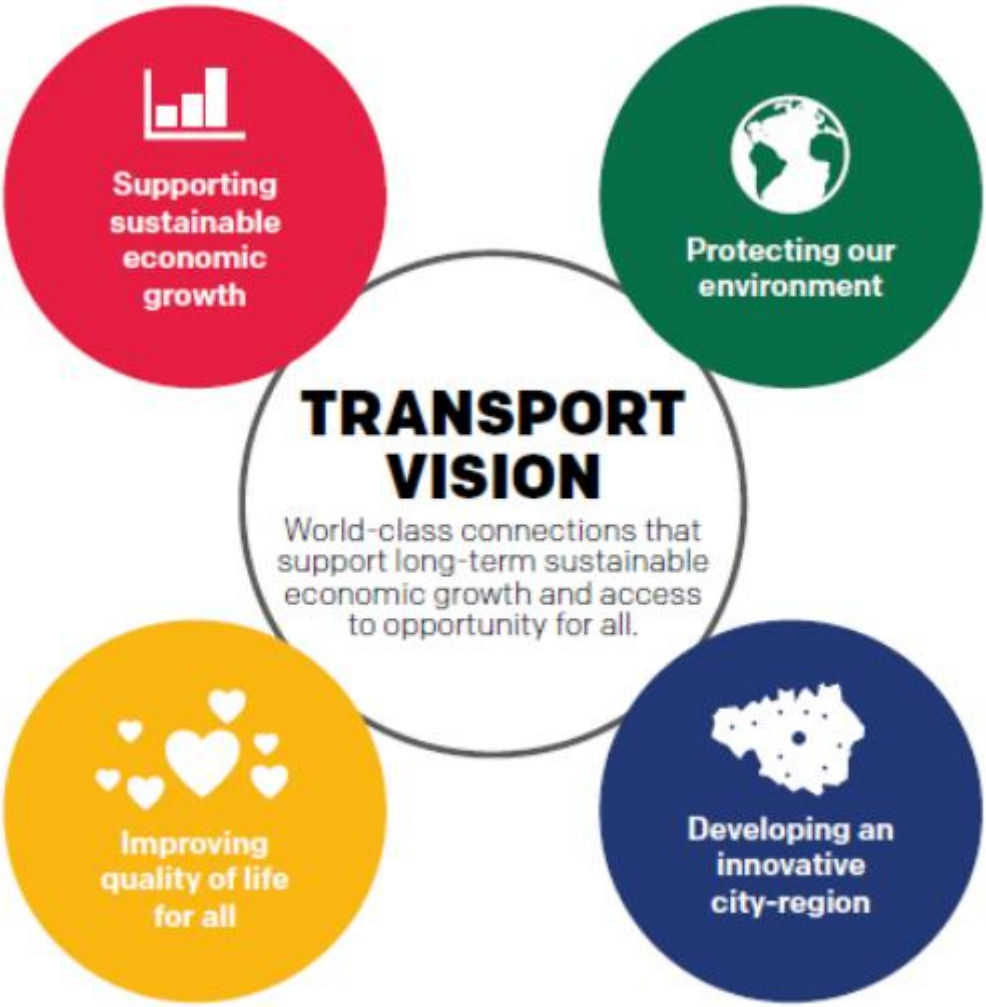



**Figure 7.1: 2040 Strategy key elements. Source: TfGM (2021, 7)**

As part of the scene setting for the policy goals, the 2040 Strategy considers the current transport, housing, education, and economic pictures in the city region, along with current trends and potential interventions available in the short and long-term. The 2040 Strategy (TfGM, 2021, p.7) states the following vision:

> "*World class connections that support long-term, sustainable economic growth and access to opportunity for all"*.

This statement, and the wider document, acknowledges transport's key role in not only supporting the development of a strong economy but enabling local residents and visitors to prosper from this development (TfGM, 2021). This correlates with arguments highlighted in chapter two, particularly those that note the relationship between transport and economic growth (Boyer & Durand, 2016; Eißel & Chu, 2014; Navigant, 2017; Sdoukopoulos et al., 2019). However, it also highlights in future there may be an increased need for more transport solutions as economic growth is a key ambition of the city region and may lead to more building work across the city region in support of this goal, with transport required to facilitate new journeys that are needed.

## 7.3 Greater Manchester 2040 Transport Strategy: Content evaluation

The 2040 Strategy, is a comprehensive document that offers clear messaging on the intentions of the city region transport authority, acting on behalf of the Greater Manchester Combined Authority, to use transport to both support and bring about presumed positive change on a number of key challenges, including health, polluting emissions, and the environmental impact of transport, and managing the impact of population and economic growth over time. Structured into specific themes, the document incorporates intentions and policy points, backed up by some evidence with the rest gathered in a separate document. The document is separated into four parts:

1. An introduction into the 2040 Strategy, which includes the critical transport challenges for the city region (sustainable economic growth, improving quality of life, innovation, and the environment)
2. Key principles and policies of the city region, which are broken into two parts: a customer focused transport system and its key principles, and the principles for each mode over the next 25 years
3. Spatial themes in the 2040 Strategy, including global connectivity, inter-city links, travelling within the regional centre (predominantly Manchester city centre and Media City, Salford), travelling across the rest of the city region, and travelling within the ten districts
4. Delivery of the strategy, including funding and measuring performance (TfGM 2017/2021).

The review took place in two phases:

1. The first phase was an initial evaluation and highlighting of content of interest based on an open-minded read through. This review considered the 2040 Strategy content, as part of a descriptive content evaluation and analysis to determine the initial goals and primary objectives of the document and how the document may impact transport operator, planner and user perceptions.
2. The second phase included a coding and analysis strategy, first discussed in the methodology and repeated at a high-level below, using a coding framework led by the first phase of document analysis and the interviews conducted.

Upon completion of the 2040 Strategy review, additional policies (highlighted in table 9) were also reviewed using the coding framework which is discussed below.

In support of phase one, the following topics were chosen prior to the read-through, to ensure relevant information was considered and captured:

- Language and use of statements

*The language used can offer insight into the boldness of intention and is of interest in relation to new forms of mobility considered within the document. The use of statements, particularly those that positively affirm the intent to achieve a goal, will offer insight into the overall policy goals of the document.*

- Evidence presented

*The evidence used to demonstrate the reasons for each intention will shed light on how ambitious the transport authority has been when considering the impact of change on the city region over time.*

- Consideration of innovative approach to support mobility

*The number, range and types of innovative approaches considered will offer insight into the openness of the transport authority to consider new forms of planning, provision and specific modes of transport.*

- Transport integration, including payments

*Already noted as a key component and challenge by interview respondents, the strategy's consideration of future ticketing and payment systems will offer clarification on the level and type of transport integration that is planned in the city region (which will then impact whether a Mobility as a Service system is feasible).*

- Acknowledgement of shared mobility

*Whilst MaaS is a relatively new term and may not be mentioned by name, newer forms of shared mobility have existed in cities for some time. If mentioned directly by brand, mode or technique, this may offer insight into the openness to accept newer forms of mobility providers*

- Strengths and weaknesses of the document

*Whilst the goal of the review is not to pass judgement on the document, the overall strengths and weaknesses in relation to the implementation of Mobility as a Service will be considered as part of the phase one review.*

These topics were chosen in advance as they represented the key themes in which intentions or actions could be grouped in relation to the implementation of MaaS, as highlighted by interview participants. As the interviews progressed and the outcomes analysed, the document was reviewed again multiple times, and the themes evolved as additional insight into MaaS, including the challenges and barriers to implementation, were explored in greater detail with more participants. The following sections breakdown the document's content based on the pre-defined areas of interest.

### 7.3.1 Language and use of statements

The 2040 Strategy clearly sets out both the issues agreed between the districts to be key challenges facing the city region, and the high-level goals associated with reducing, resolving, or removing the challenges. By focusing on the political, economic, and demographic changes the city is facing now and predicted to face in the near future, in both words and pictures, the 2040 Strategy makes clear the need for new approaches to transport planning and management if the goals are to be reached.

For example, the 2040 Transport Strategy (2021, p.5) states:

> *"Ultimately, all interventions will come together to offer flexible and customer-focused travel choices, supported by smart information, ticketing and payment systems, across a truly integrated Greater Manchester transport network".*

This is a bold statement of intent, using language that leaves little room for debate on the final aim of the 2040 Strategy. However, the statement maintains a degree of flexibility by using grouping terms as opposed to specific interventions i.e. "smart" instead of a specific action or mode. Smart implies the use of technology, but by using the term instead of naming a specific type of technology it leaves room of the selection of the intervention following additional

analysis or innovation development. This links to the interview responses where participants noted key elements of MaaS that will need to be tackled, specifically the use of data, privacy and how individuals may access the system without a digital device. Having a statement of intent in the strategy is a step towards more defined policy goals and guidelines for a MaaS system.

Alongside the use of strong language, TfGM very clearly takes ownership of both the document and its intentions by using words such as "we" in relation to delivering the 2040 Strategy and associated elements. However, when discussing modes, including popular ones such as private vehicles, the messaging tone is slightly diluted to include words such as "can" when discussing the negative impacts including emissions and noise pollution.

### 7.3.2 Consideration of innovative approaches to support mobility

Whilst phase one considers the content of the 2040 Strategy, it is worth noting that the first version of this strategy (published in 2017) included a cover designed with innovation in mind, and even featured specific modes of travel that are not currently available, including: autonomous vehicles, noted as such due to the travellers clearly facing away from the direction of travel in a vehicle similarly designed to a car; jet packs; and flying saucers. Alongside this, urban infrastructure in the background included a mixture of roads above building height. Whether created to inspire or offer to a light-hearted attempt at capturing the future of transport (as the strategy itself looks to 2040), the 2040 Strategy made a statement regarding the place for innovation in transport in the city region. At the time this may indicate a receptiveness locally to new and innovative opportunities, including MaaS. However, in the 2021 updated version, this cover has been replaced with photographs of public transport and active travel users, with a particular focus on the Metrolink tram network and cycling and walking. This may indicate a change in perspective, with an increasing focus now being placed on sustainability instead of new and novel modes that may impact residents and visitors in future. This new focus was briefly highlighted by interview participant 16 who highlighted how Greater Manchester's focus has narrowed to key elements relating to sustainable transport linked with economic growth, in place of more general innovation. Alongside this, transport policies typically aim to cover an extended period of time without ageing or becoming obsolete before a new version is published (Huber & Wicki, 2021). By choosing to use more local photographs and imagery that represents existing transport modes, TfGM may be aiming to avoid unintentionally narrowing expectations with how the network may develop in future, even if jet packs and flying saucers are unlikely to emerge as key transport modes prior to 2040.

The 2040 Strategy (2021, p.16) contains a section on "Developing an Innovative City Region", which offers a high-level overview of intentions relating to innovative concepts include how best to utilise innovative methods for improving efficiency and performance of existing networks, how to reduce consumption or use of resources, and how best to improve communications and information distribution between providers and users. This section is the smallest of the "goal setting" sections and offers very little information beyond an intention to engage with and utilise innovation as a philosophy in transport planning. This is unsurprising given the rate of change and lack of clarity on what is best to use, when and where regarding novel technologies.

Five key areas were noted as the main foci on utilising new technologies in the original 2017 version (TfGM, 2017, p.8):

- Improving performance and resilience
- Improved access to better data
- Reducing the need to travel and transport goods
- Reducing transport's impact on the environment
- Improving customer experience including safety and security

These areas of focus represented ongoing challenges in transport planning and management, suggesting a reliance on technology to solve problems that traditional methods cannot. Instigating or supporting behaviour change or modal shift is mentioned repeatedly in the document as a requirement to make a significant positive impact on the city region but was not included in the five areas of focus for innovation, suggesting more traditional methods would be utilised to support those initiatives, for example fare pricing models.

These key areas have now been removed in the updated 2021 version and replaced with narrative that focuses on cross-sectoral working and ensuring innovation is used to improve infrastructure, services and placemaking (TfGM, 2021). Alongside this, the strategy notes an intention to publish an Innovation Prospectus, to provide more detail on specific plans and areas for investment. The intention to publish a wider document on innovation and its role in relation to transport highlights an open to approach to supporting and adopting new technologies when they support policy goals. However, the removal of these points may hint at a reluctance to specifically highlight areas of focus for innovation. Instead, the narrative

included in the updated version allows TfGM to maintain their open approach to innovation bringing new benefits for the city region, without committing to specific things. Whilst this may offer a greater opportunity to explore innovation in the context of transport planning and service delivery, it does reduce the emphasis on where innovation will be sought to improve known challenges in the city region.

### 7.3.3 Transport integration, including payments

In contrast to the section on innovation, TfGM (2021) focus heavily on the use of technologies to offer accurate information to customers, alongside access to tickets and payment mechanisms. This is also the first section that directly mentions MaaS, but only in reference to "account-based travel" (TfGM, 2021, p.26):

> *"This approach could involve the development of a multi-modal, account-based travel platform, sometimes referred to as Mobility as a Service (MaaS). MaaS could be delivered through a smartcard, credit/debit card, mobile phone, or other cashless technology. Such an approach could also support a more sophisticated and responsive approach to managing demand on our transport networks through nudging travel behaviour*

This relatively narrow conceptualisation of MaaS notes only fare integration and ticketing via smart devices as part of the MaaS definition but does note that the outcomes of this intervention could support improved management of the transport networks. No additional information on how that would be achieved is included. This reference is one of two times the concept is named in the document. The intention to develop a MaaS system is clear, with the following policy goal outlined in the document:

> *"Policy 2: Working with partners, we will deliver integrated pricing and payment systems across the transport network, including smart ticketing for public transport, to support the delivery of 'Mobility as a Service'."*

Stating a clear intention to develop and implement a MaaS system is a bold choice in a public strategy, particularly one that is intended to be in use for several years. How this element might be delivered and how any references to it may change in future updates could highlight the progress made and any changes in policy goals.

### 7.3.4 Evidence presented

To ensure the strategy itself is grounded in context, for each of the named critical transport challenges sections (environment, economic growth, innovation, and quality of life), an

evidence base of the current state of play exists. The evidence gathered has been sourced from a range of areas, including publicly available information and data gathered internally or by another public organisation in the city region.

Similar to other urban areas, Greater Manchester is facing challenges relating to congestion, polluting emissions and providing accessible and affordable transport options for residents and visitors (TfGM, 2017/2021). As an example, figure 7.2 notes the sustainable economic growth predictions for the city region up to 2035-2040, which will have an impact on the current and future transport network.

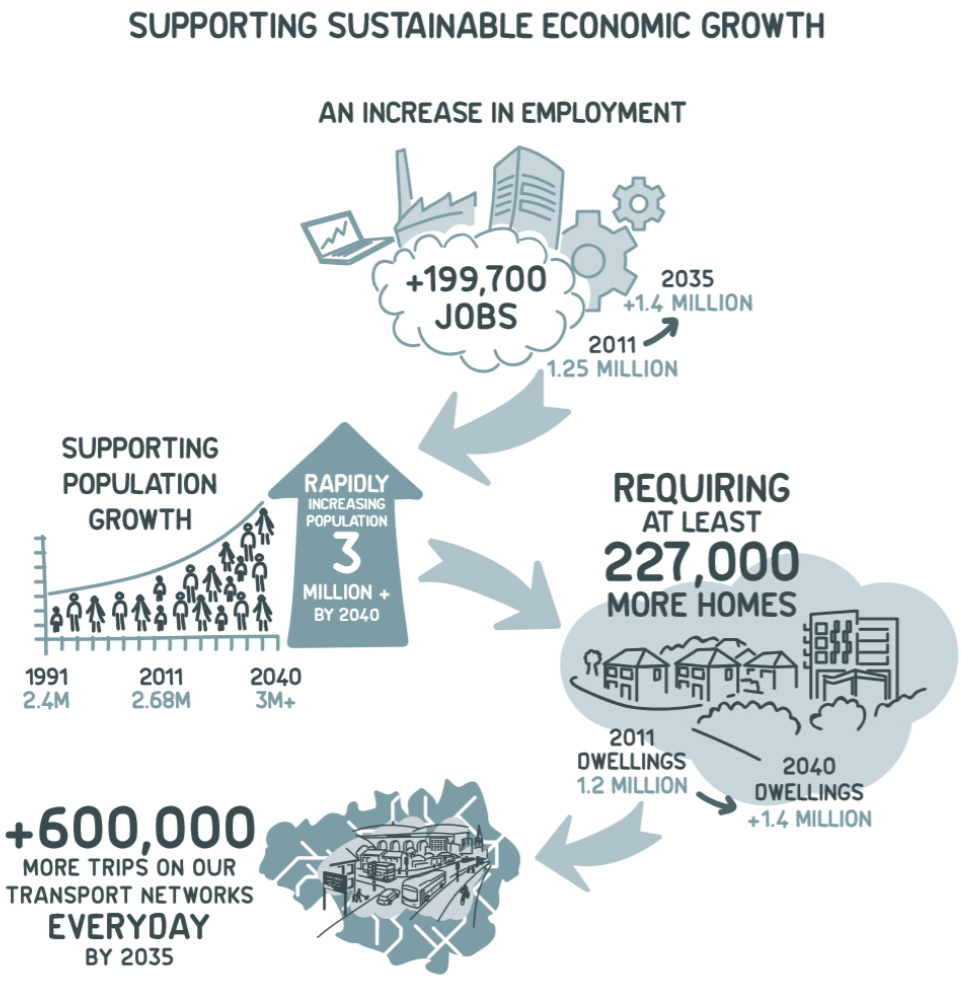



**Figure 7.2: 2040 Strategy: supporting sustainable economic growth. Source: TfGM (2017, 4)**

The growth figures represent major changes in the city region. However, the projections of growth used are bold and do not offer additional information. This additional evidence is featured in a separate document (Greater Manchester 2040 Transport Strategy Evidence Base). It is not always clear if the evidence used is the projection based on current investment and

growth or one based on assumed spending that is above current or previous levels. For example, the 190,000+ jobs by 2035 is based on an Accelerated Growth Scenario (AGS-2017) forecast that was commissioned by the GMCA and relies on improvements to the skills base, innovation, and transport connectivity (TfGM, 2017). In contrast, the Greater Manchester Forecasting Model 2-17 (GMFM 2017) predicts that under baseline conditions there will be an increase of 141,000 employees working in Greater Manchester by 2035 (TfGM, 2017). The assumption of accelerated growth, based on required improvements, suggests either significant investment in the transport network will be made to improve the likelihood of reaching the accelerated scenario or a step-change is expected to allow improved mobility for residents and users across the city region that is in some way different to mechanisms for access to transport that are already in place.

Following the 2021 version update, a new infographic has been included in the document, replacing the one highlighted in figure 7.2. This new infographic (shown in figure 7.3)

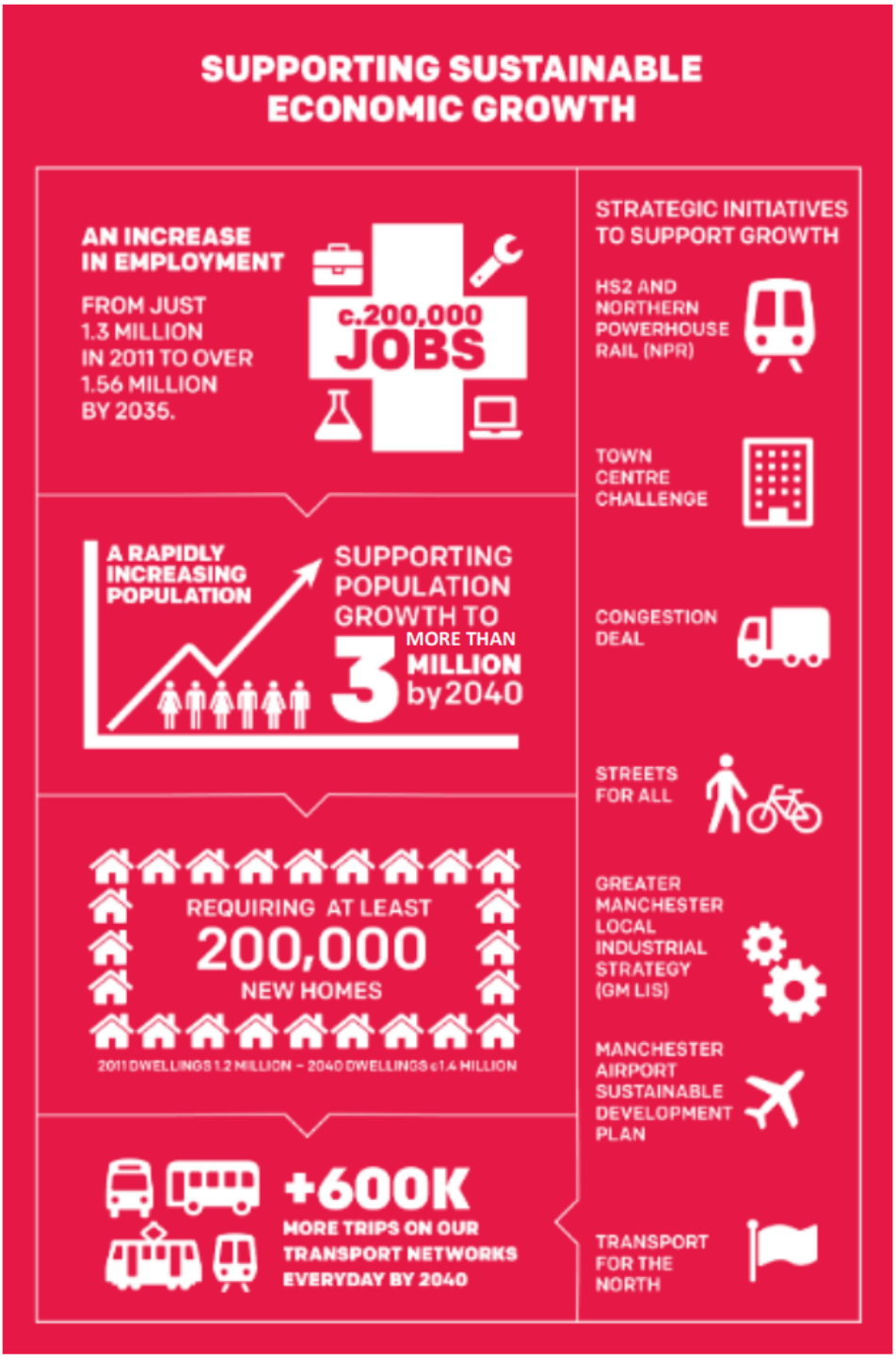



**Figure 7.3 2040 Strategy: Updated infographic highlighting economic growth. Source: TfGM (2021)**

Whilst many elements remain the same, some have changed likely in reflection of updated forecasting and work completed between the publication of the original strategy in 2017 and the updated version in 2021. Key changes include fewer houses noted as required, public

transport user growth taking five years longer than originally assumed and higher job growth by 2035.

### 7.3.5 Shared mobility

The 2040 Strategy notes the importance of traditional shared modes, including buses, trams, and heavy rail links, but does also occasionally consider newer shared mobility options and how they may play a role as part of an overall transport network in future. Initially, the shared mobility solutions appear to be aimed at younger people in an expectation that their consumer choices will be different in future, which is evidenced by considering the decline in car ownership, to those of the same age in previous years (TfGM, 2017/2021)

The modes to be used have not been defined and the overall mechanism for how these modes will be integrated into the existing transport network have also not been detailed in the document, but by mentioning the potential for their inclusion in the transport system in Greater Manchester in future, there appears to be a level of openness to these possible new transport modes or providers.

### 7.3.6 Strengths and limitations

The 2040 Strategy offers a good summary of the current state of play in Greater Manchester as a city region, and of the challenges it currently faces. The document does not offer much clarity in relation to the specific interventions to be considered and implemented (understandably in some cases as it is intended to offer intentions over a 25-year period) but does utilise many bold statements starting with “we will”, which offers insight into the intent of the transport authority to enact some form of change. This is particularly the case with the MaaS specific policy objective highlighted in the updated 2021 version of the 2040 Strategy (TfGM, 2021). However, with the manipulation of data to consider accelerated growth patterns in place of current trends, the reliability on both the challenges and need for interventions may not be accurate or realistic.

The document clearly focuses on the city region as a whole and does not offer much detail on the individual districts, with a notable lack of granularity at district level, but this in turn indicates transport planning, provision and likely management will take place centrally and region-wide, on behalf of (and in partnership with) the districts.

## 7.4 Thematic analysis categories

Nodes for coding in the thematic analysis exercise were devised using three methods:

- Using the interviews, themes relevant to potential components of a MaaS system were identified
- Urban planning themes were identified via the literature review
- As the documents were coded, themes that emerged repeatedly among many documents, i.e. safety in urban planning, were also created as nodes

Where appropriate, nodes were sub-divided to add clarity to the context of the theme. For example, the urban challenges node was sub-divided into ten additional nodes, to offer the ability to group urban challenges with more specificity. Figure 7.4 details the nodes (including sub-divisions) that were used during the thematic analyses.

The additional policies were also reviewed using a thematic analysis approach, utilising the categories identified in the analysis of the 2040 Strategy, along with a set of categories specific to urban planning. These categories were identified in the literature review as potential areas that might support the development or uptake of a MaaS system. The categories were identified in the literature review and consist of:

- Densification
- Innovation
- Placemaking
- Quality of life
- Resilience
- Safety
- Sustainability
- Transit Orientated Development
- Urban Growth
- Personalised approach
- Consideration of a range of demographics

Alongside the categories above, another category was added to the challenges group: safety. This was added after it emerged repeatedly in the policy documents as they were reviewed. Whilst it has not been mentioned alongside MaaS or as part of a MaaS system more generally, safety and the perception of safety were a common theme and therefore likely to be part of the development of transport networks and operational parameters.

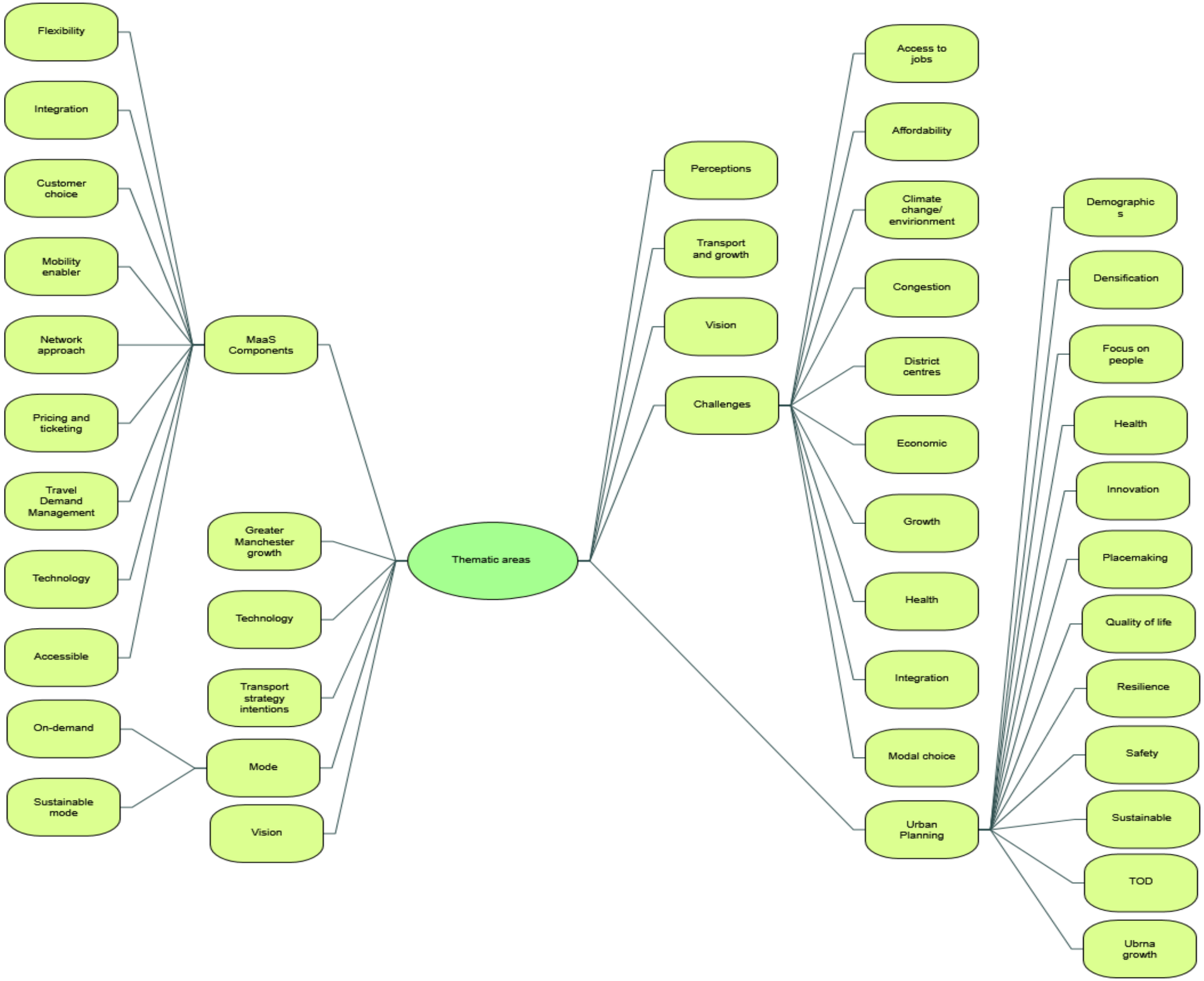



**Figure 7.4: Categories framework used in the policy analysis. Source: author**

## 7.5 2040 Transport Strategy thematic analysis

The 2040 Strategy is Greater Manchester's primary document for the strategic direction for transport. This section will detail the key themes identified in the document, including potential MaaS components.

### 7.5.1 Transport Challenges

A number of transport challenges were noted in the 2040 Transport Strategy. Climate change and the impact of polluting emissions on health and the environment were noted frequently, with TfGM (2017/2021) recognising that adverse weather conditions, paired with infrastructure that is aging, will present challenges in future as the climate continues to change. Alongside the infrastructure impacts, TfGM (2017/2021) also notes the damage and loss of habitats is cause for concern, particularly due to construction and noise pollution.

Customer choice is also a common theme, with TfGM (2017/2021) noting that some parts of the transport network are not as developed as others, which leaves few choices for residents and visitors. Alongside this, sustainable and active modes are mentioned as options that should be the natural choice for shorter journeys in future (TfGM, 2017/2021). Congestion was noted alongside customer choice, with hotspots in certain areas impacting journey times in the regional centre and motorway links (TfGM, 2017/2021).

The impact of transport on the economic success of the city was mentioned, with the pockets of significant deprivation in Greater Manchester noted as an ongoing challenge. The role of transport in supporting the night-time economy was noted, with those in lower paid roles and shift workers in particular noted as groups that suffer from poor public transport links outside peak hours. Whilst other challenges are noted, the above ones were mentioned frequently and represent issues that are also noted in other cities around the world. The following sections highlight potential MaaS components that are noted in the 2040 Strategy.

### 7.5.2 Integration

The primary focus on the document is highlighted by TfGM (2017/2021): the development of an integrated transport network. Integration is a common theme noted throughout the document, with local, regional, and global integration, via the city region's airport, all discussed. The theme of integration focuses largely on the public transport network, but TfGM (2017/2021) notes that different travel needs will be catered for as part of ongoing efforts to support improved integration of the network. Transport integration is a frequently noted theme in MaaS (Finger et al., 2015). Currently, (as discussed in chapter five) integration is a challenge

in Greater Manchester due to the regulatory and policy landscape. Ensuring integration is a feature in policy documents may improve the foundation of a MaaS system within the city region. However, integration of a range of modes across an equitably balanced transport network would also be a requirement to ensure city region residents would benefit equally.

### 7.5.3 Flexibility

Whilst flexibility is not mentioned as frequently as integration, the number of times it is noted provides a key insight into the intentions of the city region in future. TfGM (2021, p.67) states:

> *"Passenger convenience will be maximised, and journey times minimised, through optimal location of interchanges, hubs and bus stops to ensure passengers can complete journeys requiring more than one trip or mode".*

The intention to improve customer experience highlights the awareness of the current network pain points for users, particularly around interchanging and trip-chains. Length of journey, user experience and lack of convenience are noted challenges of those undertaking trips with multiple changes (Jenelius et al., 2011). The flexibility to change modes, along with a pricing system that does not penalise those who have to use multiple modes, is a commonly mentioned element of a MaaS system (Arias-Molinares and Palomares-Garcia, 2020). TfGM (2017/2021) goes on to note that part-time workers and flexible contracts are likely to increase in future, and the transport network should evolve to effectively support these trips.

### 7.5.4 Technology

The use of technology is a noted theme in MaaS, with academics and professionals both looking at applications to support ticketing and pricing platforms and to offer information to potential users, including trip scheduling and journey planning (Giesecke et al., 2016; Melis et al., 2016). TfGM (2017/2021) notes technology may mean the development and delivery of additional opportunities for integrating the transport network could emerge, particularly relating to the creation of a network that focuses on users. The ability of technology to support improved information distribution and promotion of different travel options is noted by TfGM (2017/2021). The inclusivity of information distribution is mentioned, by the use of the term "more traditional methods". These methods are not mentioned in more detail, but the ability of MaaS platforms to cater for a range of users is noted concern amongst academics (Ultriainen & Pollanen, 2018) with areas of poor connectivity, technical barriers, and the ability of technology to create a more equitable transport network all noted.

### 7.5.5 Accessibility

Creating an accessible network is mentioned frequently throughout the 2040 Strategy (TfGM, 2017/2021). Access for the elderly in particular is noted, as the elderly population in the city region is expected to grow in future. Alongside this, access to sustainable modes is mentioned and access to transport modes for those with additional mobility needs is also noted (TfGM, 2017/2021).

The sections above offer insight into areas where MaaS could provide alternatives to current transport operations and planning and highlight areas which are recognised as target themes for development in future. The following section summarises the thematic analysis of the Greater Manchester Strategy, which is the key regional planning document for the city region.

## 7.6 Greater Manchester Strategy thematic analysis

The Greater Manchester Strategy is the core planning document that sets out the intentions for development and goals to be achieved in the city region. Currently in its fifth iteration and updated in 2021, the strategy sets out the goals for the city region (Greater Manchester Combined Authority, 2021). Five core themes are identified by the Greater Manchester Combined Authority (2021, p.2) in the strategy as being the leading areas for the strategic vision in the city region:

1. *"A Greener Greater Manchester: Responding to the Climate Emergency*
2. *A Fairer Greater Manchester: Addressing Inequalities and improving wellbeing for all*
3. *A Prosperous Greater Manchester: Driving local and UK growth*
4. *Ten distinctive places: One unique GM*
5. *The Greater Manchester Approach – our shared outcomes and commitments"*

The five core themes encompass several of the themes identified in the literature review for coding, including placemaking, sustainability, a consideration of a range of demographics and quality of life. The Greater Manchester Combined Authority (2021, p.4) strongly notes that the COVID-19 pandemic and the bold targets established by the city region will require collaborative working across the districts and sectors, stating:

> *"This Strategy is a blueprint to corral and energise our partnerships, galvanise relationships, working across agencies and sectors, and provide a platform for the further development and establishment of new relationships, opportunities and ways of working."*

This inclusive approach to achieving goals hints at a deeper understanding of the benefits of community buy-in of planning schemes, along with the potential positive benefits if goals are realised. The city region's residents, workers and physical infrastructure are noted as assets that will be harnessed to reduce or remove the current challenges in Greater Manchester, which links to the Levelling Up White Paper's goals of utilising capital within areas including physical and human assets (Greater Manchester Combined Authority, 2021; HM Government, 2021). Alongside the challenging position the city region is in as a result of the COVID-19 pandemic, the strategy notes that residents across the city region have been impacted in different ways and some of these impacts will take significant time and effort to reduce and resolve (Greater Manchester Combined Authority, 2021). Using new targets as clear policy drivers for change and growth, the strategy notes the intention to develop stronger communities, accessible and inviting public spaces and increasing the number of shared spaces (Greater Manchester Combined Authority, 2021).

Technology is mentioned briefly in the strategy, with the Greater Manchester Combined Authority (2021) noting that the city region could be used as a testbed for new technologies, including large-scale projects that might benefit whole communities, with a particular focus on the use of existing assets. However, the Greater Manchester Combined Authority (2021) does not note the potential types of technologies or themes that the technologies may relate to, instead the potential for innovation is grouped along with the intention to develop research centres which support the ongoing development and testing of innovations in the city region.

As the key strategic document for the city region, the Greater Manchester Strategy sets out the goals and vision for the future. Key targets are established and principles for development are clearly laid out. The following section details the thematic analysis of the additional policies and strategic documents reviewed.

## 7.7 Thematic analysis of additional policies and strategies

Seventy-four additional policy and planning documents were reviewed, using a thematic analysis approach. A full list of cities is highlighted in table 9, with cities of a range of sizes featured. This section includes the key areas that relate to urban and transport challenges, MaaS components and urban planning components that may support the development and implementation of a MaaS system.

### 7.7.1 Urban and transport challenges

As identified in the literature review, cities around the world are facing a number of challenges (Hu et al., 2016; Karmargianni et al., 2015; United Nations, 2018). Some of these challenges stem from transport and some impact on transport operations and investment. How cities choose to resolve these challenges will impact future planning, but first, understanding the reason and impact of the challenges is key. The following sections detail the key challenges noted in the transport and urban planning policies reviewed.

#### *7.7.1.1 Climate Change*

Climate change was referenced by over two thirds of the cities in their policy documents, with the others noting emissions related pollution in ways that did not directly reference climate change i.e. noting carbon emissions specifically. The impacts of climate change were noted in particular by cities that have either suffered from historical flooding or are coastal based, including New York and Boston. The Boston Transportation Department (2017, p.44) notes

> *"Today, if a storm surge of five feet was to hit during high tide, approximately 132 miles of roadway would be vulnerable to flooding, affecting drivers, bicyclists, walkers, and transit riders. By the 2070s, the sea level could rise three feet or more, so a similar storm surge at high tide could flood 432 miles of roadway. As much as 30% of Boston's land area would flood in this scenario, including half of the downtown."*

This concern for the physical impact of climate change on infrastructure and land mass is echoed by the Greater London Authority (2018, p.14) who also raise concerns over the Urban Heat Island effect and its impact on homes, transport operations and workplaces across the city of London. The impact of climate change on citizens is also raised as a concern, particularly in relation to those already impacted by poor air quality or fuel poverty (Greater London Authority, 2018). The impact on marginalised or poorer communities has been noted in research to date, with academics also considering the uneven impact across geographical areas in relation to the impact on different demographics (Behzad et al., 2013; Gossling, 2016).

The impact of transport emissions on climate change, particularly the negative impact of emissions from motor vehicles, were highlighted several times. The Greater London Authority (2018, p.14) argues that the use of private vehicles is "overwhelmingly responsible for the greatest environmental challenges we face as a city". This bold statement recognises the negative externalities of motor vehicles, which is mirrored in similar statements by the San

Francisco Municipal Transportation Agency (2018) and Metrolinx (2018) for the Greater Toronto and Hamilton Area. Linked to the awareness of the impact of motor vehicle use is an acceptance that transitioning to low-carbon transit vehicles and sustainable, active modes will be key to providing transport choices across an urban areas that meet user needs and have a low impact the local and global climates.

Resilience in the face of a changing climate is noted repeatedly, with infrastructure investments to mitigate the impacts noted in particular. Whilst physical investment options are summarised at a high level, ongoing monitoring and evaluation is also raised as necessary with Metrolinx (2018) highlighting vulnerability risk assessments, seasonal weather readiness plans and continuous evaluation of flood risks along key transport corridors.

#### *7.7.1.2 Congestion*

As a challenge that's felt by many cities with developed highways networks, congestion was mentioned repeatedly in policy documents, along with its impacts on urban growth and citizens. Los Angeles, a city known for its investment in highways infrastructure and resultant congestion issues, raised the issue of holding the title of the longest traffic delays in the United States (Los Angeles County Metropolitan Transportation Authority, 2016). The identification and recognition of the cause of congestion, and the requirement to implement reforms to mitigate the impacts and any future growth in congestion were also noted by the Los Angeles Country Metropolitan Transport Authority (2016). The City of Melbourne (2019) accepts that a certain level of congestion is an unavoidable mark of a successful and economically prosperous city. Whilst this statement may appear controversial on initial reading, as congestion is noted to have negative economic impacts in urban areas, it does not necessarily relate to vehicular traffic with bicycle congestion on streets and pedestrian congestion on pavements noted in cities as well (City of Melbourne, 2019; New York State Department of Transportation, 2006). However, the economic cost of congestion bears a significant burden on urban areas, with the City of Melbourne (2019) stating that congestion currently costs the Greater Melbourne economy $4.6 billion per year (a figure that is projected to increase). Similarly, the City of Philadelphia (2018) notes that, on average, Philadelphia residents spend up to 42 hours each year in congestion. The City of Melbourne (2019) also notes that whilst it has the largest and one of the most popular light rail networks in the world, it is also the slowest, with an average speed of 16km/h. This in turn has an impact on user experience and customer choice, potentially making it a less attractive option than others which may be seen as quicker.

The ability to mitigate the impact of congestion, whilst also considering the impact of modes on climate change, user experience and placemaking in cities, along with the space constraints in heavily urbanised areas, is noted by several cities, including the New York State Department of Transportation (2006, p.37) who note that reducing or removing congestion without adding capacity is "one of the greatest challenges facing transportation policy makers today". The City of Philadelphia (2018) transport planners have accepted the realisation that whilst the challenge of congestion could be managed, it's unlikely to ever be fully solved.

#### *7.7.1.3 Transport network fragmentation*

Infrastructure barriers have been cited as a key reason transport networks struggle provide an integration and seamless experience for consumers (Brown and Bramley (2012). However, softer barriers including poor service integration or gaps in transport networks service patterns also cause fragmentation that can be a challenge for transport and urban planners to rectify (Bills & Walker, 2017; Brown and Bramley (2012). The City of Atlanta (2017) also points to poor wayfinding, parking spaces, disused spaces, and blank walls as reasons for network fragmentation. Interestingly, the creative and artful use of open spaces and walls in built up areas are noted as ways to both direct people to locations and offer a sense of place between transit points (City of Atlanta, 2017).

The impact of fragmentation is noted repeatedly by the policies reviewed, with particular concern given to minority ethnicities and low-income populations, who have to travel further and spend longer on transport to reach key transit links as underinvestment has left some areas with low and limited quality transportation options (Boston Transportation Department, 2017; Greater London Authority, 2018). The solution noted by some includes improved information and utilisation of better technology to improve operational efficiencies (City of Melbourne, 2019), whilst others point to using the active modes of cycling and walking to bridge the gap, offering cost effective options that are suitable for cross-urban trips (City of Dallas, 2006; Singapore Land Transport Authority, 2019; Syndicat des Transports d'Île-de-France, 2015). However, the ability to connect and invest in orbital routes, in a manner that mirrors the transport availability radially into city centres, is noted as an ongoing issue by some cities (City of Melbourne, 2019; Greater London Authority, 2018).

#### *7.7.1.4 Modal Choice*

The considerations that influence modal choice have been debated extensively by academics (Jaeger-Erben et al., 2015; Witte et al., 2013), with cost, reliability, flexibility, and ability to control the mode itself have all been noted in previous studies as impacting the decision a user

will make when considering transport mode options. Alongside this, once a user has begun consistently utilising a mode, introducing a new one or creating a change in habits can be a challenge for transport planners, even if the new options present alternative benefits (Jaeger-Erben et al., 2015). The policies reviewed in this study raise modal choice frequently when considering the impact of transport investment and service pattern changes.

The most consistent measures considered to reduce the attractiveness of private vehicles in the policies is parking and user pricing. This includes time limitations for on-street parking, greater charges to enter a space depending on type of vehicle (petrol/diesel or electric) and limiting the number of spaces available in new residential developments (along with additional costs for those using the spaces in these developments) (City of Atlanta, 2017; Greater London Authority, 2018; San Francisco Municipal Transportation Agency, 2018; Singapore Land Transport Authority, 2019). However, the ability of citizens to access education, employment and leisure facilities using other modes is considered alongside the interventions to reduce the use of private cars, with some cities arguing that cycling could offer an opportunity for flexible and reliable transport in areas that cannot be served by traditional public transport modes due to low level of demand (City of Atlanta, 2017; City of Melbourne, 2019).

New modes, including dockless bike and e-scooter sharing schemes, are noted by the City of Melbourne (2019) as an option that might enable greater uptake of cycling in the city centre, as individuals have greater control over where to leave the bicycles once the trip is finished; dockless bikes typically have more flexibility in where they can be left in contrast with docked bike hire schemes. However, the City of Melbourne (2019) goes on to state that lack of policies to control dockless bike schemes has actually meant the development of more problems, with the overall benefits being lower than first thought. These problems include a lack of control over the placement of bikes by users, bikes being viewed as low value items and incorrectly returned to areas when users are finished with their travel, and a high emphasis placed on moving bikes to suitable locations each day to ensure bikes are available to users during peak times (City of Melbourne, 2019). This sentiment is echoed by the City of Chicago (2019, p.12):

> *"…there are new modes entering the market at a rapid pace, such as electric-assist and dockless bikes, electric scooters, free-floating car sharing, and soon, the advent of autonomous vehicles… Chicago needs a clear set of principles and future-looking policies to provide the proper framework for effective integration of such new transportation options."*

The identification of new modes, along with the recognition that new policies may be needed to ensure users and urban areas more generally benefit from their use highlights an overall acceptance of innovation, the likelihood of new innovations arriving in cities and the need to evolve polices to control innovations in a similar manner to the way in which traditional mode operational parameters are controlled today.

#### *7.7.1.5 Physical and Mental Health*

The health of urban residents and visitors is of particular concern in the policy documents reviewed. This is especially the case when considering the impact of transport on health but is also considered from the perspective of urban layouts, the ability to access green space and urban acoustics and noise pollution. Vehicle emissions and the impact on public health is noted frequently, with the Los Angeles County Metropolitan Transportation Authority (2016) stating that the public health burden from vehicle emissions is estimated at $22 billion each year. This number includes lost days in employment or education, along with additional healthcare needs and premature deaths. The premature deaths alone due to transport emissions is over twice the number caused by car crashes (Los Angeles County Metropolitan Transportation Authority, 2016). In Paris, road noise exposure above regulatory limits is an issue for over 1.6 million people on average during the day, and over 800,000 during the night-time (Syndicat des Transports d'Île-de-France, 2015).

The dependence on cars has also resulted in poor physical health due to a lack of physical activity in some cities, with the two main causes of early deaths in London linked to inactivity: heart disease and cancer (Greater London Authority, 2018). The Greater London Authority (2018, p.14) goes on to state that "today's children are the first generation that is expected to live more of their lives in ill health from chronic diseases than their parents". The Greater London Authority (2018) also recognises that whilst individually the negative externalities of choices individuals might have an impact, the grouping together of urban challenges (congestion, limited access to green space, poor air quality) results in poor quality of life for the local residents. Whilst many cities note improvements are happening, all recognise a need to achieve more to create urban areas that support economic growth and quality of life for residents and visitors.

#### *7.7.1.6 Safety*

The topic of safety is raised in a number of ways by the urban policies reviewed. The majority include at least one reference to the need to reduce vehicular accidents, but some also consider bicycle and pedestrian safety, along with passenger safety when waiting for and using public

transport modes. The Boston Transportation Department (2017) notes the need to prioritise safety where incidents have happened previously and considers the value of lowering speed limits and creating residential streets that make walking and cycling attractive.

Bicycle safety, particularly when cycling alongside traffic, is an education concern for the Boston Transportation Department (2017). Alongside this, the distribution of free safety equipment such as bicycle lights and reflective materials are also noted as having the potential to improve the visibility of cyclists for vehicle drivers. However, the reliance on individuals to be visible and adjust their behaviour to suit traffic does not combat or resolve poor driving behaviours. The City of Chicago (2019) notes that the majority of incidents involving vehicles are the result of disobeying traffic signs or signals, speeding or driving whilst distracted or impaired. The City of Philadelphia (2018, p.23) concurs with this, noting:

> *The "Safety Six" are those violations most likely to result in traffic deaths or serious injuries:*
>
> *"1. Reckless/careless driving; 2. Red light- and stop sign – running; 3. Driving under the influence; 4. Failure to yield while turning or to pedestrians; 5. Parking enforcement on or within 20' of a cross walk, on a sidewalk, or in a bike lane; and 6. Distracted driving."*

With this in mind, education and equipment for cyclists does not seem to be the cause or a likely resolution of safety challenges relating to motor vehicles.

Overall safety in urban areas is noted by the Greater London Authority (2018), with high-harm offences, such as sexual offences or hate crimes, having an impact on the perception of safety when moving around the city by London residents. Poor lighting and poorly designed transit stations are noted as also impacting the perception of safety by the City of Melbourne (2019).

## 7.8 MaaS Components

Of the plans reviewed, three cities directly reference MaaS: Singapore, Sydney, and Toronto. The Singapore Land Transport Authority (2019) states that MaaS would enable commuters to use a combination of transport modes as part of a combined, single service offer. This offer would utilise local data generated by the Land Transport Authority to provide information on service patterns, including timings and locations. MaaS is noted by Singapore Land Transport Authority (2019) as an innovative solution to transport challenges.

Transport for New South Wales (2018) states that MaaS is something for the city of Sydney to move towards in future, noting that a customer-focused, data-enabled, and dynamic transport network is the goal of the city. On-demand modes, shared modes, technology improved parking and mobility packages are all noted as expected to be part of the eventual MaaS offer (Transport for New South Wales, 2018). The potential benefits of the MaaS system envisioned include integration, simplicity and convenience in pricing and ticketing, improved access to a broad range of transport modes, seamless multi-modal journeys, and real-time operational control that is achieved through improved use of data analytics. Transport for New South Wales (2018) anticipates that the transport services will be provided by a mixture of public, private and community operators.

Metrolinx (2018) recognises MaaS as an emerging trend in mobility and transport planning, noting the integrated services, a subscription mechanism for pricing and ticketing, and access to both traditional public transport and new modes in particular. The roles and responsibilities of different organisation types (public, private etc.) are noted as still being under question. To bring about MaaS in the Greater Toronto and Hamilton area, Metrolinx (2018) states the intention to develop and implement a MaaS strategy that will enable the ongoing improvement of existing ticketing and payment services, along with the development of a regional multi-modal planning system that incorporates a range of modes.

Whilst these were the only three specific mentions, pre-identified components of a MaaS system, identified through in-depth interviews with industry and academic experts, were mentioned in other policies. Twelve components were identified in total (see figure 7.4 for breakdown of all themes). The sections below detail some of the key points noted in the policy documents in relation to potential MaaS components.

### 7.8.1 Use of technology

The potential uses of technology were cited by multiple policies, with over 239 references made to the opportunities of technology in transport and urban planning documents. Terms like ‘sophisticated’ and ‘revolutionise’ were used frequently, highlighting the assumption that technology will allow for greater insight or operations than has been achieved to date, along with the assumption that the use of technology may offer greater opportunity to create radical change than cities are able to achieve with the tools currently available. The need to appear to be at the forefront of transformative technological change was also apparent in the documents, with many cities noting experience with, and ongoing openness to, trialling new technologies

before they are ready for scaled implementation. Many assumptions are made of the potential benefits these technical advancements will bring.

Classed by the Smart Nation and Digital Government Office (2018, p.1) as a "global force", the disruptive ability of new technologies was noted by city officials in Singapore, with health, transport and overall digitisation being referenced as likely to be part of a paradigm shift. The City of Atlanta (2017) argues that technology will shape transport demand in future, with new and emerging modes reflecting the changes in consumer demand. Noting the potential benefits the use of technology could bring, the city has committed to establishing innovation or smart zones to enable the deployment of these technologies in a controlled and geographically limited way. This is mirrored in other cities, who, in advance of new modes such as Autonomous Vehicles arriving on streets, are pro-actively developing policies for use of these technologies when they arrive. The City of Chicago (2019) is combining active policy generation with an openness for trialling new technologies in the city, creating an iterative approach to policy development. The intention is also to expose residents and visitors to the new technologies to build trust in advance of scaled up implementation (City of Chicago, 2019).

In Paris, the use of technology is being seen as an enabler to improve the speed and likelihood of uptake of sustainable modes, including shared sustainable modes such as electric car-sharing, bicycles and bike sharing, and Autonomous shared shuttles (Syndicat des Transports d'Île-de-France, 2015). To integrate services, the Syndicat des Transports d'Île-de-France (2015) is considering the importance of data, particularly the interactions between physical objects and systems, along with the interdependencies of systems across sectors. This includes multi-modal mobility and personalised public health, along with virtual and online education systems and open and democratic governance (Syndicat des Transports d'Île-de-France, 2015).

Participatory democracy and the ability of citizens to engage in developments that change the urban fabric is noted by the Syndicat des Transports d'Île-de-France (2015). Specifically, Syndicat des Transports d'Île-de-France (2015, p.27) states

> *"Digital technologies have become a source of inspiration for many uses within a reality that will be changed by these technologies. In the connected city, networks, hyper-connectivity and the Internet of Things form a network through which information becomes instantly accessible and citizen initiatives are able to emerge, which alter their relationships with the city and its governance."*

This is echoed by the City of Philadelphia (2018) who note that preparing residents for changes in technology and the impact this will have on cities is essential. The City of Philadelphia (2018, p.27) also notes that preparing residents for the "Future of Work" is critical, with 60% of jobs in the United States expected to be replaced by automation in the near future. The impact is predicted to be significant for entry level, replicable and routine work, and low-skill work; jobs which tend to be occupied by individuals from low-income communities (City of Philadelphia, 2018).

Accessibility in the face of new technologies has been cited as a key concern, particularly the area of digital inclusion (Syndicat des Transports d'Île-de-France, 2015). Multichannel approaches and user-friendly interfaces are noted specifically, along with improved training and education for both city employees and city residents (Syndicat des Transports d'Île-de-France, 2015). Finally, the ability of cities to protect residents and workers from risks of technology related issues (cyberattacks etc.) is noted, with improved policies and regulations mentioned specifically as methods to prevent the rights of residents and workers being challenged.

### 7.8.2 Accessibility

Accessibility was mentioned frequently in the documents reviewed, with it being used as a collective term for a range of options including pricing and ticketing, physical access, safety and ability to participate in urban life. Similarly, the Los Angeles County Metropolitan Transportation Authority (2016) notes that there are different dimensions to accessibility, but that any fair and equitable system must consider the most vulnerable users and their ability to access employment, education, and leisure opportunities. The Greater London Authority (2018) also notes the importance of catering for invisible disabilities, including mental health or long-term health conditions. The Senate Department for Urban Development and the Environment (2013) in Berlin notes that mobility should be available for the whole population equally, with the end goal of enabling equal participation in city life and the development of the city. This is echoed by the Boston Transportation Department (2017) who argue that both streets and transport should be easily accessible to all. However, the Boston Transportation Department (2017) also note that currently, that is not the case, with crowded streets, access to rapid transit, ability to board and alight from transit and culturally competent city employees to support and assist were areas that all need additional consideration.

Accessibility is mentioned frequently in relation to empowering individuals to choose alternatives to using private vehicles, with the Greater London Authority (2018) arguing that

easy to use and accessible public transport modes are reliable and convenient options. This is mirrored by the Syndicat des Transports d'Île-de-France (2015) who argue access to active travel modes is equally important.

### 7.8.3 Travel Demand Management

The potential benefits of Travel Demand Management (TDM) are noted frequently in the documents reviewed. TDM is a group term for a set of strategies and/or operational parameters that involve managing travel demand by encouraging certain patterns or by making other options look less attractive (Zhao et al. 2010). This can apply to transport and land use planning and patterns and can including pricing and ticketing strategies alongside infrastructure (Zhao et al., 2010).

The Greater London Authority (2018) notes that TDM is expected to play a key role in tackling local and community traffic and transport issues, alongside helping improve placemaking. Scheme coordination was noted by the Greater London Authority (2018) as being a key area for ongoing consideration, to ensure the benefits are shared across as wide an area as possible and to ensure changes in one area do not create negative impacts in other areas. Having anticipated the potential benefits of TDM, the Los Angeles County Metropolitan Transportation Authority (2016) enacted a TDM programme in 1993, which imposes TDM measures on businesses of a certain size or businesses which occupy space of a certain size. The Los Angeles County Metropolitan Transportation Authority (2016) is now intending to move to innovative methods of monitoring, evaluating, and updating the TDM programme, to optimise the operations and to widen the mobility services and infrastructure types included in the plan. This approach is mirrored in New York, with state-of-the-art technologies anticipated to improve the current TDM operations and present additional future options for inclusion in the plan (New York State Department of Transportation, 2006). In contrast, cities such as Melbourne are only now in the process of formally devising a TDM plan for the city, noting the requirement for a comprehensive plan is particularly necessary to tackle congestion and poor road space allocation on arterial routes (City of Melbourne, 2019).

Recognising the role of customer choice in TDM is particularly important, with the New York State Department of Transportation (2006) stating that consumers are willing to place a premium on the ability of operators to effectively manage congestion and provide information on operations (including alternative services in the event of delays or cancellations). SANDAG (2019) take this recognition one step further in San Diego by creating a second strand to manage transport effectively alongside TDM: Transportation System Management (TSM). TSM in this

case is defined as managing the overall system effectively alongside managing the demands placed upon it by consumers. This includes managing the dynamic parts of the network, particularly changes in lanes to accommodate new modes or changes in lane needs due to congestion i.e. creating express lanes that require payment or carpool (car sharing) lanes that reward people who choose to travel by car in a group instead of individually (SANDAG, 2019). The identification of a network approach being required highlights the ongoing aim to integrate both services and operations, alongside ensuring the network is able to meet user demand in future.

### 7.8.4 Integration

Integration is frequently noted alongside MaaS, particularly in relation to improving the customer experience and supporting the development of a seamless transport network (Ultriainen & Pollanen, 2018). In the policies reviewed, transport infrastructure integration was noted in particular, with cycle networks and pedestrian routes noted as being essential to connect wider public transport offers (City of Melbourne, 2019; Greater London Authority, 2018; New York State Department of Transportation, 2006; SANDAG, 2019). This was also highlighted by TfGM (2017/2021) in the 2040 Strategy and links to new initiatives such as the recently launched electric car club (TfGM, 2022).

Wider city integration is also mentioned, with the Greater London Authority (2018, 271) noting the intention to "connect up" existing and new buildings with service data including transport and energy use data, to better understand current usage patterns and to inform behaviour change. The City of Melbourne (2019) has gone a step further by incorporating overall integration (and the responsibility for integration) into all levels of government.

Whilst integration may seem straightforward, connecting transport infrastructure, scheduling and ticketing is a complex endeavour. However, it's frequent mention alongside MaaS makes it difficult to picture a MaaS system without this component.

### 7.8.5 Reliability and flexibility

Reliability and flexibility were included as key themes as they were identified by interview participants regularly as possible components in a MaaS network. However, both themes were noted in the policies reviewed infrequently. When noted, reliability was cited alongside user frustration as being responsible for a lack of confidence in transport services. The Boston Transportation Department (2017) noted the reliability is of particular concern, with the on-time performance for underground lines at 87% whilst the performance for buses is 68%. Some

cities recognised reliability in relation to tackling congestion, with the City of Philadelphia (2018) noting that there is very little space available to expand highway networks, therefore improving reliability of alternative modes will be a key consideration when trying to manage congestion. Alongside this, reliability will add a level of predictability to the lives of residents and visitors, enabling more informed choices relating to transport modes to be made (Seattle Department of Transportation, 2015).

In contrast, flexibility is mentioned alongside the intention to give users more choice and greater access to more frequent modes, with SANDAG (2019, p.35) noting:

> *"Making transit more convenient. Market research shows that if trains and buses come by at least every ten minutes, people don't have to plan their day around transit. Instead, transit is planned around them."*

The recognition that currently users must plan their days around transport highlights an accepted need to change how public transport is viewed as part of daily lives. Alongside this, the need to implement resilience in the network's flexibility so it is able to respond to sudden environmental, political and economic changes and instabilities is noted by Metrolinx (2018). Both, Metrolinx (2018) and the Singapore Land Transport Authority (2019) note that new technologies could be used to implement and continuously improve the level of flexibility required to meet user expectations and needs as they are today and as they develop over time.

## 7.9 Urban Planning thematic analysis

Having considered the challenges urban areas face, and how they have been addressed in policy and planning documents, this section considers the urban planning interventions noted in the documents, with a particular focus on interventions that may support the implementation of a MaaS system. These themes were identified as part of the literature review and from the interview participants, as they relate to either key elements of MaaS or the outputs MaaS aims to deliver i.e. integrated transport.

Several key areas were prevalent in the policy documents, with sustainability and placemaking being the most noted theme overall. The use of technology and innovation also dominate the documents, which highlights an intent to adopt and use new technologies when they offer an improvement to service performance or operations. This links well to the concept of MaaS, which is frequently cited as offering benefits which would positively impact sustainability goals, through the use of technology and innovation (Mulley et al., 2018; Pangbourne et al. 2020).

### 7.9.1 Sustainability and placemaking

Sustainability and placemaking were mentioned more frequently than any other urban planning theme, with 109 and 106 references in the documents noting intentions related to either theme. Notably, the two themes were frequently mentioned in the same sentence or were linked together in some way. The City of Amsterdam (2011) notes that by increasing the greenery and overall sustainability in the city, placemaking will take place organically in the metropolitan landscape. This is mirrored in the City of Atlanta's (2017) idea to cultivate a collection of neighbourhoods in Downtown Atlanta, to offer an attractive public realm that is also convenient for those accessing employment, education, or leisure opportunities.

Recognising the potential for both green and urban growth, resulting in attractive places that support improved quality of life for residents, the Senate Department for Urban Development and the Environment (2013) in Berlin aims to create densified spaces and creative environments that include open spaces, experimental design and construction, and innovative methods of urban planning. Similar methods are being implemented elsewhere, with cities using placemaking and sustainability initiatives to encourage the uptake of walking, local employment opportunities and local leisure spaces (City of Boston, 2017; City of Chicago, 2019; City of Dallas, 2006; City of Melbourne, 2019; Syndicat des Transports d'Île-de-France, 2015). The City of Paris (2018) notes that the greening of the city is in response to demands by citizens to improve their well-being, communities, adaption to climate change and quality of life. This motivation has required creative methods, as space for new parks or other types of green space is limited. Therefore, the City of Paris (2018) is utilising space on rooftops and creating green walls and buildings, as part of an overall strategy to improving greening more generally across the city.

The intention to invest in both sustainability and placemaking highlights recognition at the planning level that cities are no longer just economic drivers in countries that people flock to due to lack of other choices. Instead cities are now areas that must attract new residents and visitors to support urban growth, by offering inviting spaces and range of services and opportunities. Alongside this, cities are now competing for skills and talent, with other cities nationally and also on an international scale. Creating an innovative and attractive place to live and work chimes well with the MaaS concept, which aims to offer a personalised experience for users. Whilst it may not have been directly mentioned, MaaS is often linked to supporting sustainability goals and wider goals regarding city growth through attracting new residents and workers, as highlighted in chapter two (Pritchard, 2022).

### 7.9.2 Transit Orientated Development

As highlighted in chapter two, Transit Orientated Development (TOD) is not a new concept in transport planning (Liu et al., 2020). The concept involves investment in residential, office and leisure construction being focused on areas that have transport capacity or future plans to increase or improve capacity. The end result is integrated land use and transport planning methods. The City of Dallas (2006) is prioritising TOD, with the intention to establish a clear link between transport planning and land use and investment. The goal for the City of Dallas (2006) is to create a transport system that can support the current transport needs whilst also supporting the additional needs of future users. The Los Angeles County Metropolitan Transportation Authority (2016) is taking this one step further by viewing the entire transit corridor as an area for employment and housing growth, with stations and stops linked by cycling and walking infrastructure to improve overall access to a range of modes when it suits the user.

Typically, TOD is mentioned alongside densification in policy and planning documents. The City of Melbourne (2019) is considering the benefits of creating dense, mixed-up spaces in the urban area, with the intention to also restrict the development of out-of-town shopping and leisure centres. This is an about turn for many cities, as out-of-town malls and shopping centres have risen in popularity in previous years due to easy access via highways for drivers and the provision of often free or low cost parking for shoppers (Gossling, 2016; Moroni & Minola, 2019). The intention to shorten trips to key destinations is mirrored in other strategies, with the San Francisco Municipal Transportation Agency (2017, p.52) noting that research evaluated to date shows that by improving density and diversity of land use in areas with well-developed transport options, emissions can be reduced by almost 65%. The City of Seattle Department of Transportation (2016) has adopted six principles for TOD, as shown in table 10, to guide future land use planning and infrastructure investment.

**Table 10: Table detailing the 6 principles of TOD. Source: City of Seattle Department of Transportation (2016)**

| Principle | Summary |
|---|---|
| Destinations | Align major destinations along a reasonably direct corridor so that they can be efficiently served by frequent transit |
| Distance | Provide an interconnected system of pedestrian routes so that people can walk to |

| | |
|---|---|
| | transit service quickly and conveniently from the places they live, work, shop, and play |
| Density | Concentrate higher densities as close to frequent transit stops and stations as possible to minimize walking distances to more destinations for more people |
| Diversity | Provide a rich mix of pedestrian-friendly uses to facilitate street-level activity throughout the day and night, increase affordability, and enliven the public realm |
| Design | Design high-quality, pedestrian-friendly spaces that invite walking and bicycling. Quality Environment |
| Demand Management | Provide attractive transportation |

These six principles have been cited frequently in academic literature and offer a simplified strategic direction for land use planning and transport planning organisations (Natalia & Heinrichs, 2019; Ogra & Ndebele, 2014).

The intention to incorporate TOD (or some of its principles) into future investment and development choices, highlights an overall need to integrate the different elements of city planning and operations to create a more cohesive experience for the user and a more manageable network for operators and planners. This intent to connect or link up different elements of city operations is in line with descriptions of potential MaaS systems ,which aim to offer a seamless experience, as highlighted by interview participant 2.

### 7.9.3 Use of Innovation

The term innovation can frequently be used as a ‘collect all’ word to capture the development or implementation of products, services or processes that are seen as more advanced than the ones that they replace, whether through the use of technology or newly developed methods (Gobble, 2014). In the policy documents analysed, innovation stemmed from two areas: the need to encourage the development of high-skilled, creative, and digital jobs, and the need to implement new innovations to improve city services for residents and visitors. These two areas consider innovation as processes, service changes and methods, along with product changes.

The City of Melbourne (2019) argues that creating high-skilled, highly paid jobs will organically improve living standards and will also enable the ongoing creation of more innovation. This idea is mirrored in City of Paris (2018, p.20) policies, which note the creation of an "Arc de L'Innovation" (a group of towns on the outskirts of the city that intend to use innovation as a basis for urban growth, improved quality of life and employment focused on specific sectors that benefits working class people). In contrast, the City of Seattle (2016) intends to use innovation to change the role of streets, instead focusing on them as public spaces that could be temporarily or permanently altered to create markets, street parks or seasonal festivals.

Singapore's Smart Nation and Digital Government Office (2018) sees innovation as a mechanism for urban solutions, with the end goal of making homes more sustainable and more comfortable, along with also making them safer. Sensors and "smart systems" will be used alongside "Open Innovation Platforms" to create these improvements (Smart Nation and Digital Government Office, 2018, p.7). The Smart Nation and Digital Government Office (2018, p.22) goes on to note that a "dare to try" mindset should be adopted in the face of new innovations, with an open mind being championed to allow for experimentation of new ideas. Risks that can be effectively managed are noted, but failure is also welcomed as a possibility and not a reason to refrain from adopting innovative methods (Smart Nation and Digital Government Office, 2018).

The development of policies and frameworks specific to the theme of innovation is common in the policy and planning documents reviewed. The City of Vienna (2014) has created a Smart City framework to guide decision making at a senior and officer level. The Senate Department for Urban Development and the Environment (2015) in Berlin has created a Smart City Strategy, to ensure innovations meet city goals. Similarly, Metrolinx (2018) has created a Toronto-Waterloo Innovation Corridor to enable the development, testing and implementation of new technologies that could benefit inter-regional mobility and growth.

Whilst innovation is never clearly defined, the need to adopt new processes, services and products is recognised frequently. The receptiveness of cities to innovation, whether focused on mobility or not, may influence the likelihood of a MaaS system being developed locally.

### 7.9.4 Safety

Actual crime and the perception of crime were noted in the documents reviewed, with cities recognising that both safety and fear of crime are separate themes that need to be tackled as

part of urban growth. Many cities noted declining crime rates, but also noted the need to do more (Boston Transportation Department, 2017; City of Atlanta, 2017; Senate Department for Urban Development and the Environment, 2013).

Whilst safety isn't a component frequently mentioned alongside MaaS, it is a theme that is present in all the policy and planning documents reviewed. The recognition of creating safe spaces and networks, and reducing the perception and fear of crime is noteworthy as a core theme in urban and transport planning that is likely to impact any MaaS system.

### 7.9.5 Densification

The ability to provide services to a population across an area, whilst maintaining cost efficiency, is a key concern for many urban areas (Ewing et al., 2016). Encouraging high density housing and mixed-use buildings (buildings that combine retail/office and residential spaces) is a common theme is the policies reviewed. The impact of densification on the provision of services and the ability to access resources are noted in particular, with cities recognising that creating a human scale in urban areas will support the uptake of active modes and the development of local communities (City of Melbourne, 2019; City of Paris, 2018; Greater London Authority, 2018). Densification was not mentioned as a core component in the interviews conducted, however the ability to deliver equitable access to a transport network has been mentioned and densification is a planning method that may contribute to this.

## 7.10 Chapter Conclusion

This chapter has detailed the policy landscape for Greater Manchester and a range of innovative cities around the world. The purpose of the chapter was to shed light on whether key themes noted in literature debating the concept of MaaS, and those mentioned by the experts interviewed, were present.

In some instances, many themes were similar across several cities, whilst in others each city has taken a more unique approach to taken challenges on a local scale. This highlights that whilst engaging with noted topics, such as MaaS, is of interest in some areas, many are more concerned with specific components i.e. integration, smart ticketing, accessibility, than in engaging with the wider topic. This could be due to several factors, including not wanting to align with a single concept which is not yet proven, but it still shows that many cities and city regions suffer similar issues and are focused on providing solutions that meet the local needs.

This chapter also highlighted that some of the problems facing cities are not new and are instead ongoing issues which have either been in existence or have been getting worse over time.

Similarly, interview participant 14 noted how transport and wider mobility represents wicked problems in cities. Participant 14 (2020) went on to note:

> "*…we need more participatory engagement from different perspectives and different disciplines and remain much more open minded in our approach to the prospect of MaaS or the prospect of autonomy and the two coming together if we're really going to understand how best to negotiate this Wicked Problem."*

How this could be incorporated in policy documents represents another challenge for cities, both in relation to MaaS and more generally to solving transport related challenges. The next chapter details the gaps in transport service provision in Greater Manchester and considers how MaaS could play a role in filling these gaps.

# 8 Chapter Eight: Travel patterns in Greater Manchester

This chapter analyses the travel choices of Greater Manchester residents. Through the critical analysis of transport patterns in the city region, the chapter highlights gaps in service provision and considers the role of MaaS, and other relevant initiatives including active travel schemes, in improving access to mobility services in these areas. The city region is undergoing major infrastructure and service pattern changes, following the publication of the Beelines proposal and the Bus Services Consultation (as part of the city region's bus franchising progress) which ran from October 2019 to January 2020.

As highlighted in chapter five, Greater Manchester is a complex city region which is undergoing transport related challenges typical of its size, including congestion, polluting emissions and fragmentation due to historical infrastructure investment that prioritises private vehicle users (TfGM, 2021). As the largest economy in the North of England, Greater Manchester has adopted several policies that highlight the city region's intend to utilise innovation and novel concepts as the city region continues to grow and develop (see section 7.2.1 for more information).

Overseen by Transport for Greater Manchester (TfGM), the transport landscape includes a range of traditional and novel modes, including fixed transport (trams, trains), buses, bicycle hire and on-demand transport such as taxis and private hire. Section 5.2 provides details on transport types and funding within the city region. This chapter details the modal choices made by commuters, factors that may impact travel choices, and considerations that will influence transport operations.

The chapter has been split into the following sections:

- A desktop analysis, which aims to understand what influences the choices individuals make in their daily journeys
- Analysis on transport patterns currently seen in Greater Manchester, including:
    - Trip purpose
    - Trip length
    - Trip journey time
- Analysis of public transport accessibility in Greater Manchester, including any gaps in provision by location

The chapter concludes by summarising the insights learned, in advance of chapter nine which brings together the insights gained from the three research chapters.

## 8.1 What influences transport mode choices?

It is well documented that transport choices impact the physical and mental health of those making them, the individuals around them and the wider environment (Bagloee et al., 2016; Eißel & Chu, 2014; Hensher & Puckett, 2007; Martinez & Viegas, 2017; Sdoukopoulos et al., 2019). The negative physical impacts (carbon emissions, congestion, poor air quality, noise pollution) in particular have been well communicated in academic literature, professional documents, and media publications (Hoffman et al., 2017). However, the evidence of impact has yet to make a substantial difference to the choices made by individuals on a daily basis, leading to the question: what influences transport choices?

Based on a significant body of research, it is acknowledged that travel behaviour is habitual and that it is influenced by trip distance, cost, private vehicle ownership, gender and wider accessibility needs (Best & Lanzendorf, 2005; Hoffman et al., 2017; Ng & Acker, 2018; Tai et al., 2018). Similarly, the Department for Transport (2010, p.2-3), notes the key influencers on travel behaviour include:

- ***"Attitudes**. Although there are sometimes contradictions between what people say and what they do, attitudes are an important influence on transport behaviour. For example, the perception that public transport is unsafe to travel at certain times of the day and that cycling is 'dangerous' have been identified as key barriers to more people travelling by these modes. Broader attitudes to issues like privacy, health, and the environment can also cross over into transport and affect the travel choices that individuals and organisations make.*
- ***Structural factors**. These are external conditions (typically physical, technological, legal or financial) beyond the control of individuals and most organisations. Structural factors are particularly pertinent in transport because behaviour in this area is often mediated by the availability, accessibility, location and cost of infrastructure – from the provision of bus services in rural areas to the availability and cost of low-emission cars.*
- ***Knowledge and awareness**. People/organisations need to know about new or existing initiatives or types of behaviour and understand what the benefits are for them. People take more notice of benefits that they themselves value. For*

*example, the Concessionary Travel Club is an online journey planner specifically for older people who qualify for a concessionary bus pass. It allows users to search for places of interest in*

- *a chosen area (e.g. museums, galleries, council offices) and enables them to plan their journey by bus or some other form of public transport. People also need to trust the source of information and be communicated with in a language they can engage with, otherwise they are unlikely to be persuaded to act on the information and change their behaviour.*
- ***Social and cultural norms**. People, and also organisations, are influenced by the behaviour of others, from their friends and peers to society as a whole. Even if a change is beneficial to them individually, they may still be deterred from changing if it means going against the prevailing attitudes and behaviours of those around them. However, if changes are viewed positively amongst peers then this may help to support change. An example here is the extent to which over the past 30-40 years behaviour and attitudes to drink driving have changed so that it is no longer the social norm to drink drive to/from pubs – although there are some specific groups amongst whom this is still acceptable, partly due to peer pressure and social norms amongst those particular segments of the population.*
- ***Habit.** Repeated behaviour can become automatic over time, meaning that people, and decision-makers within organisations, don't stop to weigh up the pros and cons each time they undertake the behaviour. This makes habitual behaviour much more of an effort to change. However, where changes to habitual travel behaviour can be achieved, the magnitude of impact could be significant. Seatbelt wearing as an example of habitual behaviour changing over time, due to a crucial combination of measures. In this case, legislation was introduced after it became normal for some to wear a seat belt and public awareness had been raised through social marketing.*
- ***Costs.** The relative costs of different behaviours are another influence on the day-to-day transport choices made by both individuals and organisations. People's perceptions of these costs may not be strictly accurate, but nonetheless influence their choices. For example, people often perceive car use to be cheaper than taking public transport for the same trip but don't take into*

*account all the associated costs of motoring, such as tax, insurance, maintenance, and vehicle price depreciation. Research has also shown that people tend to prioritise short-term costs and benefits over longer-term considerations. For instance, people and organisations may be deterred from investing in new lower-emission technology despite the long-term savings they could make from reduced fuel costs.*

- ***Capability and self-efficacy.*** *People may be prevented from adopting a new behaviour if they don't think they have the capability to do it – either because of a perceived lack of skills or resources, or a shortage of time. Similarly organisations, particularly smaller ones, may have been convinced of the potential benefits of a change in behaviour, but still be prevented from changing because they believe they lack the skills or resources in their workforce to do so."*

The Department for Transport's (2010) recognition of psychosocial factors influencing mode choice concurs with McCarthy et al. (2016) who refer to a study conducted by Sattlegger and Rau (2016): the study noted that parents who chose not to own and/or use a private car as the main mode choice were viewed negatively by peers, which may influence their future choices. Following this, social-psychological theory has been noted as potentially being able to nudge travel behaviour by creating mechanisms to make other modes more appealing (Hoffman et al., 2017). For example, the Theory of Reasoned Action and (later) the Theory of Planned Behaviour have both been tested in relation to transport mode choices (Ajzen, 1991; Fishbein & Ajzen, 1975; Hoffman et al., 2017). Similarly, "nudging" behaviour relates to the Stages of Change Model, developed by Prochaska and DiClemente (1983). This Model, which draws on the Theory of Reasoned Action and the Theory of Planned Behaviour, looks at how ready an individual is to change how they behave (Prochaska & DiClemente, 1983). Whilst the Model initially related to smoking habits, it offers insight into behaviours across other areas including mobility choices.

In Europe, a study conducted by Giuliano and Dargay (2006) suggested that the rise of car ownership relates to rising income: as income rises, the relative price of owning and using a private vehicle declines and the individual's value of time increases, making car travel a more attractive option. According to the Organization for Economic Co-Operation and Development (OECD), between 2003-2018, the population in the periphery of metropolitan areas all around the world has grown faster than in urban cores. Rapid urbanisation together with rising

motorisation results in urban sprawl, congestion and longer commuting distances (OECD, 2018). To support these movements, major infrastructure investments in highways have created an attractive model for job decentralisation (Giuliano & Dargay, 2006; Harbering & Schluter, 2020).

### 8.1.1 Transport choices: vulnerable users

Those classed as vulnerable (seniors, disabled persons, and the elderly, alongside those experiencing transport poverty) are typically more likely to suffer from mobility related challenges which impact their ability to access education, employment, and leisure opportunities (Zhang et al., 2021). Understanding and catering for the travel behaviours of this group is essential to create an inclusive transport system. How these users' needs differ from other travel user groups requires consideration to ensure the resultant transport system, whether it be MaaS or an alternative, offers equitable access (Mayaud et al., 2019; Zhang et al., 2021). The use of technology, including applications and online payment systems, may limit access to MaaS platforms for some potential users. Alongside this, considering how a range of potential users could interact with active travel mobility options will be essential, to ensure any infrastructure investment does not exclude travellers (Mayaud et al., 2019; Zhang et al., 2021).

### 8.1.2 Events that disrupt travel behaviour

Typically, travel behaviour is habitual, and patterns can exist over long periods of time, even when alternative options become available that may be preferable (Gravert & Collentine, 2021). However, some life events are classed as disruptive enough to cause individuals to re-evaluate their travel choices and adjust the priorities in which they would traditionally have chosen a mode and or method of trave (Gravert & Collentine, 2021; McCarthy et al., 2016). At these points, the new travel patterns can be influenced (McCarthy et al., 2016). These disruptive events can include moving home, changing jobs, the birth of a child, and changing educational needs. Using these disruptive events, studies have highlighted that new travel patterns can be formed, if nudges are applied at the right time (McCarthy et al., 2016).

## 8.2 Analysis of transport patterns in Greater Manchester

Using 2001 and 2011 census data, travel patterns within the city region have been analysed (Office of National Statistics, 2001; Office of National Statistics, 2011). The tables below focus on transport for commuting purposes, using private vehicles. Following this, the next section considers how well-connected different areas of the city region are for public transport. Whilst trip purposes can vary, commuter transport is likely to be the more predictable type of trip to plan as many commuters still travel at similar times of the day (what has traditionally been

referred to as “peak” travel times). With this is mind, if MaaS were to cater to a large group of individuals, commuting journeys could be the first group to see a benefit, as journeys are more predictable and are often repeated several times in the same week. However, how shift workers and those in unpredictable working situations, including the gig economy, are catered to would require further study. Alongside this, MaaS is frequently cited as being key to enabling the transition away from habitual car use to a more flexible approach to modes for journey (as highlighted in chapter two). The trips included in the tables are made by private vehicle, and as such offer an insight to the scale of the challenge for commuting journeys. Whilst analysis on travel patterns will be routine in a transport authority, to the best of this author’s knowledge this type of analysis has not been undertaken, using this data, with a focus on areas with transport provision gaps where MaaS could provide new mobility options for travellers.

## 8.3 Commuter trips within Greater Manchester

As highlighted in table 11, trips to the regional centre make up a considerable portion of daily commuter journeys. However, the district centres are also clearly trip attractors (Office of National Statistics, 2001; Office of National Statistics, 2011). To cater for these trips, a radial network is required, and is already in place in the city region. However, orbital journeys also require transport provision (Smith & Barros, 2021). In the instances of lower numbers moving between districts for commuter journeys, modes that can cater for more flexible journey patterns could provide a wider range of transport options for travellers (Guan & Wang, 2019). This is particularly the case for on-demand and active travel transport options.

Alongside journeys to the regional centre, some districts supply more jobs than available workers in the district. As noted in table 12, where the number is above one, the district has more occupied jobs than workers residing in the district. As such, more workers are travelling into the district to fill these roles. Understanding the volumes of travellers into and out of each district, for employment and also for leisure and education purposes, will aid in understanding what service options would be required to support the volume of commuter journeys in to and out of each district. This would require wider consideration of job roles as resultant wealth will influence willingness to pay values, length of journeys and interchange requirements.

In terms of trip distance, as highlighted in table 13, residents of Manchester district travel on average further for their commute than other districts. This is particularly interesting as this district is a large employment hub, containing the city region’s “regional centre”. Whilst a large proportion of district residents clearly work within a close distance (as highlighted by the red colour in table 13), the overall distance travelled demonstrates that some residents are travelling

further for work. The distances above 20km also highlight that commuters may be travelling outside of the city region all together, possibly into highly paid positions in other nearby cities i.e. Liverpool, Sheffield, or Leeds. Additionally, those travelling over 60km may be commuting to London, which has direct rail links with Manchester. Creating a city-to-city MaaS system, to cater for journeys to other cities and locations around the UK could enable these commuters to travel to professional roles outside of the city region, but coordination with both transport operators and local councils would be required.

As highlighted in this section, commuter travel, whilst largely predictable, has some variations which will need to be accounted for in a MaaS system, including longer distance commuter trips, those commuting trips which may be less frequent i.e. for those in professional role with mixed in office and at home working, and those workers who commute via orbital travel routes around the city region. The following section will consider public transport provision at a postcode sector level in the city region.

**Table 11: Travel within Greater Manchester by residence and place of work, with green indicating a higher volume of travellers travelling to that area. Source: data collected from the Office of National Statistics (2011) and analysis undertaken by the author**

| | | Place of Work | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bolton | Bury | Manchester | Oldham | Rochdale | Salford | Stockport | Tameside | Trafford | Wigan |
| Residence | Bolton | 62464 | 5080 | 7017 | 806 | 1270 | 6459 | 767 | 461 | 3097 | 4476 |
| | Bury | 4786 | 32936 | 12130 | 1911 | 4095 | 5689 | 961 | 815 | 2652 | 647 |
| | Manchester | 1579 | 2490 | 108658 | 4525 | 2394 | 10090 | 11713 | 3729 | 17100 | 942 |
| | Oldham | 610 | 1220 | 11712 | 45747 | 5869 | 2178 | 1673 | 4606 | 2005 | 380 |
| | Rochdale | 925 | 4868 | 9269 | 8003 | 40260 | 2279 | 894 | 1041 | 1928 | 360 |
| | Salford | 3627 | 2154 | 18919 | 993 | 965 | 39355 | 1640 | 751 | 12461 | 1658 |
| | Stockport | 565 | 558 | 25549 | 1389 | 622 | 3203 | 55275 | 4392 | 5780 | 328 |
| | Tameside | 455 | 568 | 17483 | 4872 | 1025 | 2576 | 8518 | 41324 | 2996 | 291 |
| | Trafford | 897 | 644 | 24760 | 746 | 540 | 6496 | 3998 | 985 | 41677 | 676 |
| | Wigan | 9110 | 894 | 5415 | 509 | 506 | 5845 | 737 | 298 | 3532 | 68238 |

Table 11 highlights how travellers move between districts within the city region to access their place of work. In particular, the green cells show a higher proportion of travellers moving from a district into another one. For example, whilst travel within districts for employment takes place, travel from districts to Manchester, which houses the regional centre, is also popular. This shows that the regional centre is a hub for employment, and the radial routes created in the transport system reflect travel requirements for those with this pattern of commuting.

**Table 12: Ratio between occupied jobs and workers in Greater Manchester, with a number above 1 denoting more workers than jobs. Source: data collected from the Office of National Statistics (2011) and analysis undertaken by the author**

| | Bolton | Bury | Manchester | Oldham | Rochdale | Salford | Stockport | Tameside | Trafford | Wigan |
|---|---|---|---|---|---|---|---|---|---|---|
| Bolton | 0.9251445 | | | | | | | | | |
| Bury | | 0.771697 | | | | | | | | |
| Manchester | | | 1.47599559 | | | | | | | |
| Oldham | | | | 0.9144868 | | | | | | |
| Rochdale | | | | | 0.8241225 | | | | | |
| Salford | | | | | | 1.0199581 | | | | |
| Stockport | | | | | | | 0.8823993 | | | |
| Tameside | | | | | | | | 0.7290408 | | |
| Trafford | | | | | | | | | 1.1450399 | |
| Wigan | | | | | | | | | | 0.8202852 |

Table 12 shows that whilst Manchester does have a higher volume of workers than jobs, Salford and Trafford also have a similar challenge. This means that these workers will be travelling outside of their districts, or outside of Greater Manchester, to access to work. Alternatively, following the Covid-19 pandemic which resulted in a rise in home working, some workers may no longer choose to commute to an office at all.

**Table 13: Distance travelled to work by district, with the higher volumes coloured red. Source: data collected from the Office of National Statistics (2011) and analysis undertaken by the author**

| | Less than 2km | 2km to less than 5km | 5km to less than 10km | 10km to less than 20km | 20km to less than 30km | 30km to less than 40km | 40km to less than 60km | 60km and over | Work mainly at or from home | No fixed place | Total distance (km) | Average distance (km) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bolton | 20844 | 28434 | 24049 | 13639 | 5218 | 1501 | 1053 | 1425 | 10086 | 8697 | 932391 | 9.7 |
| Bury | 13711 | 16053 | 13572 | 9546 | 2533 | 871 | 1671 | 1640 | 7689 | 6151 | 671347 | 11.3 |
| Manchester | 42576 | 60879 | 76932 | 60689 | 17172 | 8912 | 10826 | 9343 | 15288 | 17128 | 4491630 | 15.6 |
| Oldham | 18504 | 24569 | 16306 | 9388 | 2765 | 1143 | 1009 | 898 | 7349 | 7116 | 619861 | 8.3 |
| Rochdale | 16975 | 18331 | 14714 | 9136 | 3179 | 1041 | 879 | 924 | 7075 | 6930 | 596518 | 9.2 |
| Salford | 18041 | 19988 | 23939 | 21856 | 5842 | 2955 | 2633 | 2930 | 7987 | 7581 | 1402167 | 14.3 |
| Stockport | 20869 | 29149 | 25792 | 15866 | 4242 | 2126 | 2410 | 2336 | 13362 | 9751 | 1140584 | 11.1 |
| Tameside | 17792 | 20492 | 13871 | 7697 | 1961 | 875 | 962 | 1042 | 7651 | 7185 | 545734 | 8.4 |
| Trafford | 17082 | 25488 | 27540 | 24558 | 7547 | 3020 | 3271 | 2947 | 11166 | 7332 | 1508303 | 13.5 |
| Wigan | 24543 | 27263 | 21222 | 12671 | 5044 | 1894 | 921 | 1978 | 10864 | 11325 | 992469 | 10.4 |

Table 13 highlights that many workers within the city region travel less than 20km to their place of work. The exception for this, is residents of Manchester district, who travel further than those living in other districts. Manchester has rail links with other cities across the country and the district is linked with motorways, offering residents several ways of accessing employment further afield.

## 8.4 Transport Accessibility in Greater Manchester

With many of the assumed benefits of MaaS relating to transport flexibility and ease of access, understanding the current public transport accessibility gaps in Greater Manchester is critical to understanding how MaaS may provide benefits relating to service and transport mode provision. With around 13,000 points of access to the public transport network in the Greater Manchester region, measuring the ability of Greater Manchester residents and visitors to access key attraction points and areas of interest allows for a better understanding of the quality of existing provision (in terms of service availability) and where any gaps currently exist (TfGM, 2021). In Greater Manchester, transport accessibility is measured using the Greater Manchester Accessibility Levels (GMAL): detailed and accurate measurements of how accessible the public transport network (and Local Link services) are based on provision of services and distance to walk to access the service (TfGM, 2021). Based on the Public Transport Accessibility Level (PTAL) method, GMAL has been adapted to also consider the local transport services available in Greater Manchester (including the flexible transport provided by Local Link).

TfGM (2021, p.1) notes that GMAL incorporates the following elements:

- *"Walking time from the point-of-interest to the public transport access points;*
- *The number of services (bus, Metrolink and Rail) available within the catchment;*
- *The level of service at the public transport access points – i.e. average waiting time; and,*
- *The operating areas of Local Link (flexible transport) services)."*

However, TfGM (2021, p.1) also notes that the GMAL model does not include:

- *The speed or utility of accessibility services;*
- *Crowding, including the ability to board services; or,*
- *Ease of Interchange.*

The GMAL model is calculated using the following steps (TfGM, 2021, p.2):

- *Defining the point of interest (POI);*
- *Calculate the walk access times from the POI to the service access points (SAPs);*
- *Identify valid routes at each SAP and calculate average wait time;*

- *For each valid route at the SAPs calculate the minimum total access time;*
- *Convert total access times to the Equivalent Doorstop Frequencies - to compare the benefits offered by routes at different distances;*
- *Sum all EDFs with a weighting factor in favour of the most dominant route for each mode;*
- *Addition of 2.5 to the overall index score, if the POI is located within a Local Link operating area; and*
- *Application of eight banded accessibility levels*

## 8.5 Greater Manchester connectivity by public transport

Using the GMAL model, transport connectivity levels across the region have been analysed, by considering the speed, distance, and time it takes to travel to three chosen destinations:

- The nearest district centres
- The regional centre (a nominated point in Manchester City Centre)
- Manchester Airport

. The following sections detail the results of the steps above and discuss the limitations of the analysis.

## 8.6 Greater Manchester Average

Initially, the average travel time, speed, and distance across the city region to each focus area was considered and is highlighted in table 14. Table 14 shows that the average travel time by public transport to the regional centre is 42 minutes, the average to Manchester Airport is 62 minutes and the average travel time to the nearest district centre is 23 minutes.

The following terms were included in table 14:

- MCC = Manchester City Centre
- MIA = Manchester International Airport
- Nearest DC = Nearest District Centre

Following this analysis, the next stage considered the top five and bottom five “performer areas” within the data. During this analysis, particular attention was paid to the time it took to travel the distance to each focus area.

**Table 14: Greater Manchester average distances, speeds, and time to travel to the nearest district centre, Manchester Airport and Manchester City Centre. Source: Author created using date from TfGM (2019)**

| | Distance (KM) | | | Time (mins) | | | Speed (KMPH) | | |
|---|---|---|---|---|---|---|---|---|---|
| | MCC | MIA | Nearest DC | MCC | MIA | Nearest DC | MCC | MIA | Nearest DC |
| GM Average | 15 | 24 | 5 | 42 | 62 | 23 | 21 | 23 | 14 |

## 8.7 Travel time to focus areas from different locations

Table 15 shows the top and bottom performers for travel to the regional centre, with the results ranked by time to travel. Locations below 5km were removed from the rankings, as the locations immediately surrounding the nominated city centre point were emerging as having the lowest travel time. However, whilst these locations have been removed from the ranking, Manchester district postcodes still had lower journey times than postcodes in other districts.

**Table 15: The top and bottom five areas for travel time to the regional centre. Source: Author created using date from TfGM (2019)**

**Manchester City Centre**

| Top 5 | Postcode Sector | District | Distance (KM) | Time (mins) | Speed (KMPH) |
|---|---|---|---|---|---|
| 1 | M40 | Manchester | 5 | 21 | 15 |
| 2 | M9 | Manchester | 6 | 23 | 17 |
| 3 | M14 | Manchester | 5 | 23 | 13 |
| 4 | M11 | Manchester | 5 | 23 | 13 |
| 5 | M6 | Salford | 5 | 24 | 14 |

| Bottom 5 | Postcode Sector | District | Distance (KM) | Time (mins) | Speed (KMPH) |
|---|---|---|---|---|---|
| 100 | WN6 | Wigan | 39 | 79 | 30 |
| 99 | WA13 | Altrincham | 20 | 77 | 17 |
| 98 | WN2 | Wigan | 31 | 68 | 27 |
| 97 | WN5 | Wigan | 39 | 68 | 35 |
| 96 | WN4 | Wigan | 35 | 67 | 31 |

Table 16 highlights the top and bottom five areas for travel time to Manchester Airport and table 17 highlights the top and bottom five areas for travel time to nearest district centres. Whilst those within the Manchester district are able to travel to the airport in less time, interestingly, those living in M90 (located 1km away from the Airport) have poor access to the airport via public transport.

**Table 16: The top and bottom five areas for travel time to Manchester Airport. Source: Author created using date from TfGM (2019)**

**Manchester Airport**

| Top 5 | Postcode Sector | District | Distance (KM) | Time (mins) | Speed (KMPH) |
|---|---|---|---|---|---|
| 1 | SK7 | Stockport | 6 | 27 | 15 |
| 2 | M1 | Manchester | 17 | 29 | 36 |
| 3 | M20 | Manchester | 9 | 32 | 19 |
| 4 | M23 | Altrincham | 5 | 32 | 10 |
| 5 | WA15 | Altrincham | 6 | 32 | 11 |

| Bottom 5 | Postcode Sector | District | Distance (KM) | Time (mins) | Speed (KMPH) |
|---|---|---|---|---|---|
| 100 | M90 | Altrincham | 1 | 9 | 5 |
| 99 | M22 | Altrincham | 4 | 22 | 10 |
| 98 | OL14 | Rochdale | 48 | 125 | 23 |
| 97 | WA3 | Wigan | 31 | 96 | 20 |
| 96 | WN6 | Wigan | 45 | 95 | 29 |

**Table 17: The top and bottom five areas for travel time to the nearest district centre. Source: Author created using date from TfGM (2019)**

**Nearest District Centre**

| Top 5 | Postcode Sector | District | Distance (KM) | Time (mins) | Speed (KMPH) |
|---|---|---|---|---|---|
| 1 | BL11 | Bolton | 1 | 5 | 11 |
| 2 | M2 | Manchester | 1 | 5 | 12 |
| 3 | M3 | Manchester | 1 | 8 | 10 |
| 4 | WN1 | Wigan | 2 | 8 | 12 |
| 5 | SK1 | Stockport | 1 | 9 | 9 |

| Bottom 5 | Postcode Sector | District | Distance (KM) | Time (mins) | Speed (KMPH) |
|---|---|---|---|---|---|
| 100 | M44 | Altrincham | 10 | 69 | 9 |
| 99 | OL14 | Rochdale | 11 | 55 | 12 |
| 98 | M29 | Bolton | 10 | 48 | 13 |
| 97 | WA12 | Wigan | 12 | 45 | 17 |
| 96 | M41 | Altrincham | 9 | 43 | 13 |

### 8.7.1 Understanding potential gaps in provision

Whilst understanding the overall provision and accessibility of public transport in Greater Manchester is important, understanding the gaps in provision is equally vital. It could be in these areas that new modes or transport planning concepts such as MaaS are able to offer mobility options to residents and visitors that are not currently available. The reasons for the lack of availability are also of interest, as they could inform future provision i.e. if there's low population densities a traditional public transport service may be unsuitable for this location.

In order to understand gaps in provision, scatter plot charts were created. These charts show anomalies in the data, for postcode areas that have an unusual relationship between distance to be travelled and travel time, to a location.

### 8.7.2 Gaps in provision: Accessing Manchester City Centre

Figure 8.1 highlights travel to Manchester City Centre, by distance and travel time. Six points have been circled following data analysis, for additional investigation as they are either unusually low travel time for the distance to be travelled, or the opposite.

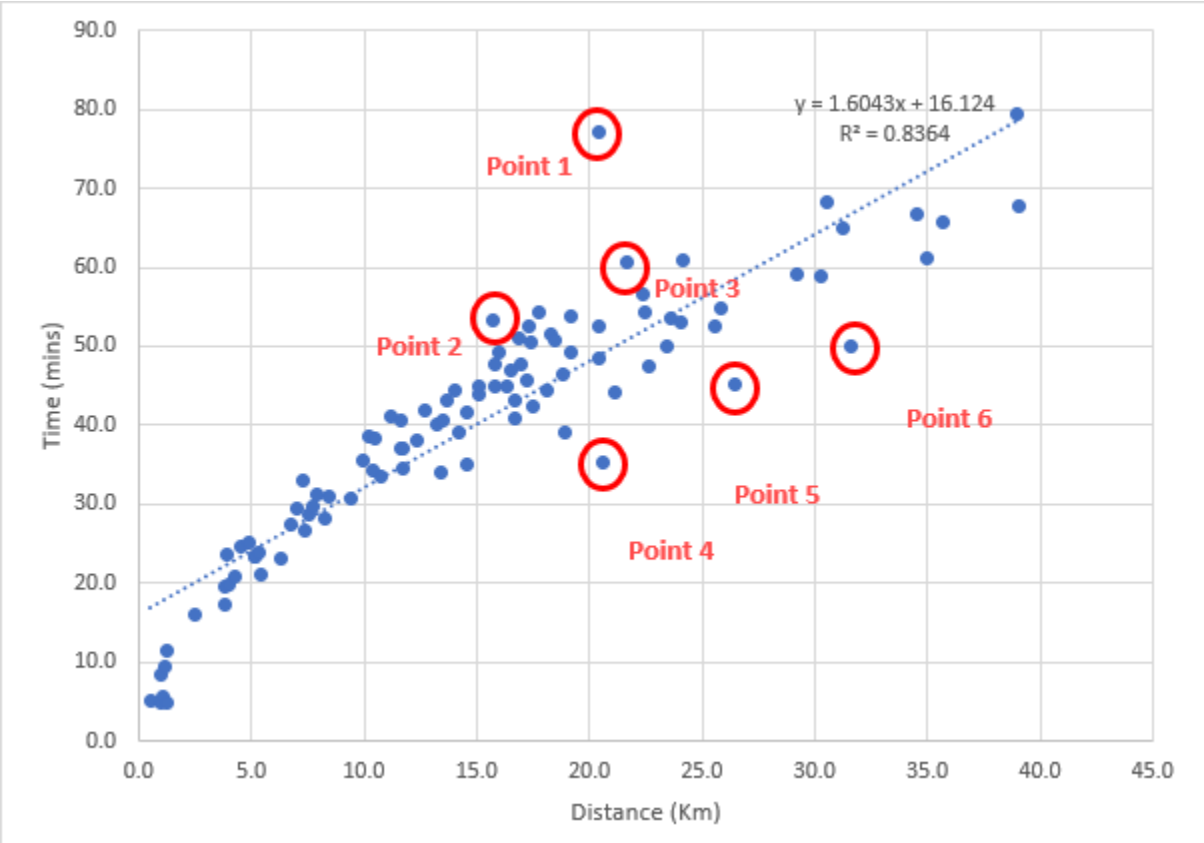



**Figure 8.1: Scatter plot diagram of travel time by distance to Manchester city centre. Source: Author created using date from GMAL (2019)**

The circled points have been listed in table 18 and are further analysed in the following sections.

**Table 18: Scatter plot points for further analysis. Source: author**

| Point number | Post code group | District | GMAL (time) | Regression estimate | Residual | Included/Excluded |
|---|---|---|---|---|---|---|
| 1 | WA13 | Trafford | 77.1 | 48.9 | -28.2 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 2 | OL10 | Bury | 53.3 | 41.3 | -11.9 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 3 | SK12 | Stockport | 60.6 | 50.8 | -9.8 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 4 | BL1 | Bolton | 35.3 | 49.1 | 13.8 | Excluded based on further analysis |
| 5 | OL15 | Rochdale | 45.3 | 58.1 | 13.2 | • Included<br>• Journey time quicker than predicted by the regression<br>• High performer |
| 6 | WA12 | Wigan | 50 | 66.9 | 16.8 | • Included<br>• Journey time quicker than predicted by the regression<br>• High performer |

#### *8.7.2.1 Point 1 WA13 Analysis*

The postcode group of WA13, sits partially inside and outside the city region. It has been included in the GMAL model and as such, the analysis will be included here. The postcode sector is predominantly rural, with a border with Lymm and Hale. For a travel distance of 20km, the estimated travel time (77.1 minutes) is significantly higher than the regression estimates of 48.9 minutes for this distance. Using pre-selected journey planners (TfGM's recommended planner "Travel Line" and Google Maps), the journey can be completed via tram and bus combinations, but each journey requires at least 1 interchange and at least 28 minutes of walking. As an area on the outskirts of the city region, which is predominantly rural, access

to the city region relies on first going to a larger transport hub which requires orbital travel in advance of radial travel into the city centre.

#### *8.7.2.2 Point 2 OL10 Analysis*

OL10 is located in the Bury district and includes the town of Heywood. Whilst the postcode sector is in relatively close proximity to Bury district centre, the only method of reaching the city centre is via bus. Due to the routing of buses, the frequency of stops (58 in this case) and the overall distance, the travel time ranges from 50 minutes to 1 hour and 3 minutes depending on the service chosen. Whilst some suggested routes direct the traveller to Bury first, in advance of using the Metrolink to travel into the city centre, these recommendations have a longer journey time.

#### *8.7.2.3 Point 3 SK12 Analysis*

Sitting on the edge of the city region, SK12 is a predominantly rural area, which incorporates part of the village of Poynton, which sits outside of Greater Manchester to the south-east. With a low population density and significant distance to the city centre, travel time via public transport ranges from 1 hour to 1 hour and 26 minutes. All trips using public transport require several interchanges and incorporate routes which initially take the passenger away from the city centre and instead use orbital patterns to direct the traveller to a larger town to interchange to a different service. As this location is predominantly rural, the options for traditional public transport are limited. There may be opportunities for first-last mile transport, including active travel, as the distance to the main public transport interchange (in Hazel Grove) is 4 miles away. When considering only public transport, the route to the interchange is an estimated 24 minutes via a circuitous route. However, when including the option of cycling, this leg of the journey reduces to 14 minutes, offering passengers a shorter and more direct option.

#### *8.7.2.4 Point 4 BL1 Analysis*

BL1 is located in the district of Bolton, incorporating the North section of the main district centre. As it includes the main district centre, which has a rail station and a new transport interchange, links to the city centre are frequent and different options are available. However, in order to access the interchange and the city centre, journey planners recommend routes that incorporate several points of interchange. The GMAL model estimates for 20km, the average journey time would be around 35 minutes. However, using journey planners currently available, the average public transport route has a 1-hour journey time. Following additional analysis using the regression estimate, this point was excluded from further consideration and classed as an anomaly due to the considerable difference between the GMAL and regression

estimates, and the journey planner recommendations. The limitations of the analysis, which could explain the significant difference, have been included at the end of this chapter.

#### *8.7.2.5 Point 5 OL15 Analysis*

Point five is located on the edge of Greater Manchester, at the northeast corner of Rochdale district. A predominantly rural area, the postcode sector incorporates only one town: Littleborough. With a direct train service to the city centre, Littleborough travel time can be as low as 21 minutes if moving between the train stations of Manchester Victoria and Littleborough only. However, transport outside of Littleborough to the rest of the postcode sector is limited and as such, additional time is added to the journey by incorporating interchanges and several walking legs into the journey. Whilst this location has many similarities to point 4, the ability to access a direct, higher speed rail service into the city centre lowers the overall journey time. However, similarly to point 4, first-last mile transport, including active modes, could play a key role in helping those within the postcode sector better access the main transport hubs local to the area.

#### *8.7.2.6 Point 6 WA12 Analysis*

WA12 borders Greater Manchester to the south-west, arguably split between being inside and outside of the city region. As the postcode sector has been included in GMAL, it will also be included in this analysis. The postcode sector borders Newton-le-Willows, which has a direct heavy rail link with the city centre. Due to the close proximity (a 14-minute walk from the centre point of the postcode sector is advised by journey planners), residents and workers in this location are within easy reach of a key transport hub, linking Liverpool and Manchester city centre's. As such, the majority of this journey is undertaken in a short time (around 19 minutes) and the remaining time is taken by walking to and from the rail stations. As highlighted by the scatter plot, a journey of this distance taking this amount of time is unusual in the city region. In this case it can be attributed to the close proximity to the rail corridor. Alternative routes recommended by the journey planning services direct travellers first to Leigh (via bus) and then on to the city centre (via bus again). This suggestion adds an additional 40 minutes to the journey time.

#### *8.7.2.7 Thoughts on city centre Connectivity*

The R-squared is 0.83, as highlighted in figure 8.1. This means that the data presented fits well to the trend line, which denotes a strong relationship exists between the independent variable (distance) and the dependent variable (time). As highlighted in the chapter five, Greater Manchester has several major transport corridors and residents, and visitors are able to access

a range of modes to travel to the city centre. Over time, a radial transport network has been created, to enable more, quicker, and better access to the city centre. The points highlighted above, showing areas that do not fit to the trend line, are areas which either sit in close proximity to major transport corridor and therefore are able to access a route with few interchange requirements and that allows for travel at higher speeds i.e. rail, or are locations in rural areas that have no direct link and instead require some form or orbital travel to reach an interchange point in a larger town. These areas in particular could make good case studies for first-last mile transport, including active travel, to enable residents and visitors to have access to a wider range of public and sustainable transport facilities.

The following sections will consider gaps in provision for connectivity to Manchester Airport (the city region's nominated "global gateway" and a major employment centre and destination for onward travel for residents and visitors) and the nearest district centre, which represents connectivity to local facilities including leisure, employment, and education.

### 8.7.3 Gaps in provision: Accessing Manchester Airport

Figure 8.2 highlights travel to Manchester Airport, by distance and travel time. Manchester Airport represents a key destination point in the analysis, as it's highlighted frequently in TfGM's (2017/2021) 2040 Strategy as being a global gateway for people and freight, a major employer, a key destination for onward travel and an arrival point for residents and visitors. Six points have been circled for additional investigation as they are either unusually low travel time for the distance to be travelled, or the opposite.

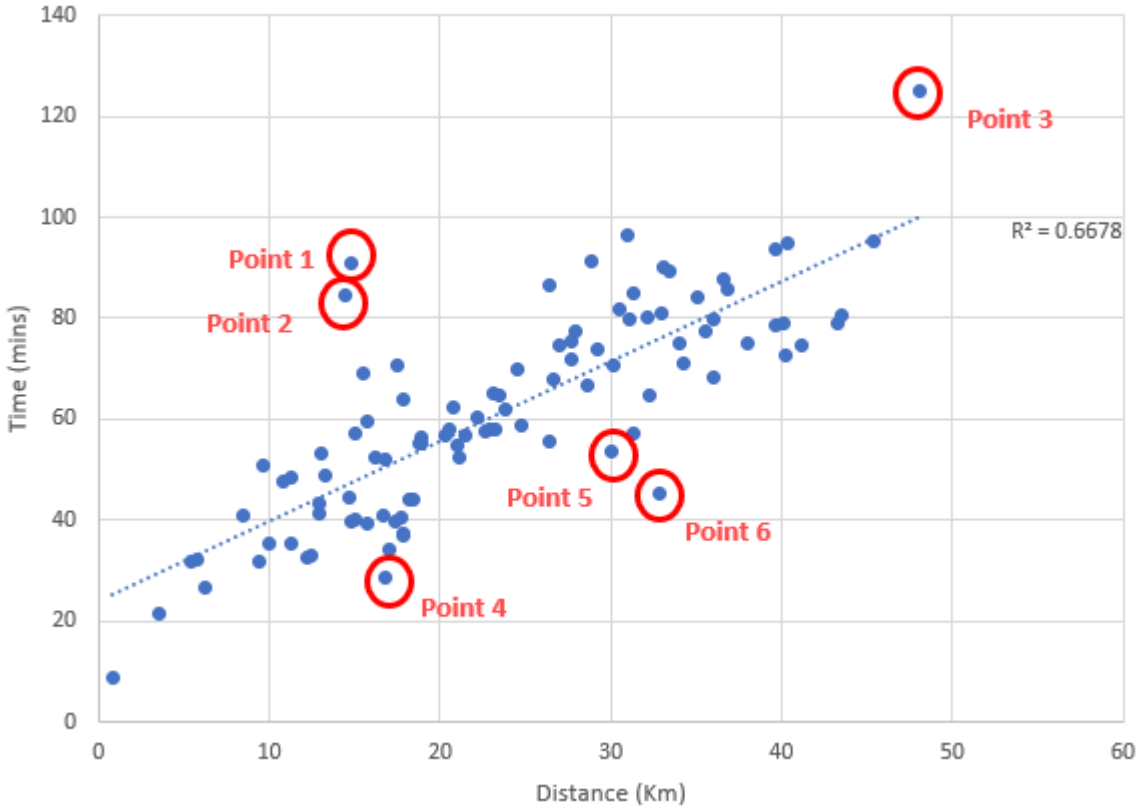



**Figure 8.2: Scatter plot chart showing travel time by distance to Manchester Airport. Source: Author created using date from GMAL (2019)**

The circled points have been listed in table 19 and will be further analysed in the following sections.

**Table 19: Scatter plot points for further analysis. Source: author**

| Point number | Post code group | District | GMAL (time) | Regression estimate | Residual | Included/Excluded |
|---|---|---|---|---|---|---|
| 1 | WA1 3 | Trafford | 90.8 | 47.4 | -43.5 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 2 | SK1 2 | Stockport | 84.3 | 86.8 | -37.5 | • Included<br>• Journey time slower than predicted by the regression |

| Point number | Post code group | District | GMAL (time) | Regression estimate | Residual | Included/Excluded |
|---|---|---|---|---|---|---|
| | | | | | | • Under performer |
| 3 | OL1 4 | Rochdale | 125 | 100.13 | -24.9 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 4 | M1 | Manchester | 28.7 | 50.5 | 21.8 | • Included<br>• Journey time quicker than predicted by the regression<br>• High performer |
| 5 | OL5 | Ashton | 53.5 | 71.6 | 18.1 | • Included<br>• Journey time quicker than predicted by the regression<br>• High performer |
| 6 | BL1 | Bolton | 45.3 | 76.1 | 30.8 | • Included<br>• Journey time quicker than predicted by the regression<br>• High performer |

#### *8.7.3.1 Point 1 BL1 Analysis*

BL1 is a district in Bolton, bordering the district centre. As noted in the previous section, BL1 was excluded due to the significant difference between the GMAL estimates, regression estimate, and journey planner recommended route travel time. In this instance, whilst the difference between the GMAL and regression estimates is significant, the journey planner estimate matches the regression estimate, so the postcode sector will be included for analysis. Discussion on why the estimates may differ has been included in the limitations section at the end of the chapter. Bolton interchange has a direct route to Manchester Airport, via the city

centre, which can be undertaken in 41 minutes. The additional travel time is due to the public transport routing between the postcode sector centre point and Bolton interchange. The presented options include a 14-minute bus journey, a 21-minute bus journey or a 10-minute bus journey. Alternatively, upon further investigation of the options, the interchange can be accessed via a 9-minute cycle or a 30-minute walk. This highlights a potential flaw in the journey planning software at the time of analysis, as cycling and walking were not considered as main "modes" when alternatives such as buses were available.

#### *8.7.3.2 Point 2 M1 Analysis*

M1 is a postcode sector located within the city centre, a 6-minute walk to Piccadilly station: a key transport hub with direct links to Manchester Airport. Due to the close proximity to this hub and the lack of any interchange requirements, travellers can access a direct route at higher speeds, leading to this postcode sector overperforming against the independent variable (distance).

#### *8.7.3.3 Point 3 OL5 Analysis*

OL5 is located in the Ashton under Lyne district and includes the town of Mossley within the postcode sector. Benefiting from close proximity to a heavy rail station (within a 9-minute walk), which links directly to Piccadilly station in the city centre, the Airport can be reached with only one interchange, in between 50-minutes and 1-hour. This is an over performing location, which, as a small town, has unusually good links with both the city centre and Manchester Airport. The links are due to the line being a transport corridor to Huddersfield and Leeds.

#### *8.7.3.4 Point 4 WA13 Analysis*

Based in Trafford, WA13 incorporates areas both within and outside of Greater Manchester. Bordering the town of Lymm, the postcode sector is less than 15 kilometres from Manchester Airport. However, a recommended public transport journey (based on journey planners used) can take up to 2 hours and 12 minutes. Both the GMAL estimated time and the regression estimate vastly underestimate the travel time to Manchester Airport in comparison to the journey planner estimates. In the previous section, postcode sector BL1 (point 4) was excluded due to the difference between the estimates and the journey planner. However, in this instance travel time appears to suffer due to the lack of a direct route, in any leg of the journey. It cannot be completed, according to journey planner recommendations, in less than 5 legs (2 of which are walking before and after the first and last modes used). In comparison, the journey can be undertaken via bicycle in less than an hour. This location offers an interesting insight into an

area where there are several public transport services available but lacks a direct route; even when using interchanges, the route frequently directs the traveller away from the final destination.

#### *8.7.3.5 Point 5 SK12 Analysis*

As noted in the previous section, SK12 is a predominantly rural area, which incorporates part of the village of Poynton, which sits outside of Greater Manchester to the south-east. Accessing Manchester Airport poses a similar challenge to accessing the city centre via public transport: travellers are required to undertake a circuitous route that means travelling a longer distance than the actual distance between the start and end point. The journey cannot be undertaken using fewer than 3 modes, including a walking journey to the first bus link. However the anticipated quickest route uses 6 modes and includes 2 walking legs, 2 bus journeys and 2 train journeys. In reality, this many interchanges adds significant risk to the journey as in the event of a single delay, the entire journey could be impacted. In rural areas like this, alternative options in the event of a delay are unlikely to be readily available. Relying on public transport for employment in this instance could pose a challenge. However, as a rural area on the outskirts of the city region, the requirement to improve the connectivity to the Airport may not be required. More information on residents and employment choices would be required to understand more.

#### *8.7.3.6 Point 6 OL14 Analysis*

OL14 sits to the north of the city region, which the majority of the postcode area outside of the city region boundary. However, as some of the postcodes within the sector are present in GMAL, it has been included in the analysis. With the highest divergence from the trend line, this location has an unusually long travel time for the distance to be covered. In reality, using the journey planners available, the journey can be undertaken using two train legs, interchanging at Manchester Victoria, with walking at either end of the journey. It appears to offer a relatively straight forward journey, however on closer in inspection, due to a lack of public transport provision at Todmorden train station into the surrounding areas, a 46-minute walk is the only option to reach the station. This adds another possibility for how first and last mile transport could play a key role in locations with poor connectivity to local transport hubs. However, as a predominantly rural postcode sector, the requirements would likely be ad-hoc and as such, flexible transport may prove more successful than traditional transport planning options.

#### *8.7.3.7 Thoughts on Manchester Airport Connectivity*

The R-squared is 0.66, as highlighted in figure 8.2. Whilst the relationship is not as strong as connectivity to the city centre, it would still be classed as moderate. Understanding transport patterns to Manchester Airport would provide additional insight into the frequency of trips. Providing public transport services to this type of employment hub, where employees would typically work shifts over a 24-hour cycle as opposed to 9am to 5pm, would be a greater challenge than to provide commuter services to the city centre. Alongside this, non-commuter trips to this type of destination would likely be ad-hoc and infrequent, leading to another challenge in adequately judging and allocating public transport provision. Visitors to the Airport looking to access the city centre are well catered for, with several options available. However, for residents the situation is more complex. This type of hub could offer a case study destination for a MaaS system, particularly as Manchester Airport is looking to move 50% of passenger travel to public transport modes as it reaches 45 million passengers per annum (Manchester Airport Group, 2016).

### 8.7.4 Gaps in provision: Accessing District Centres

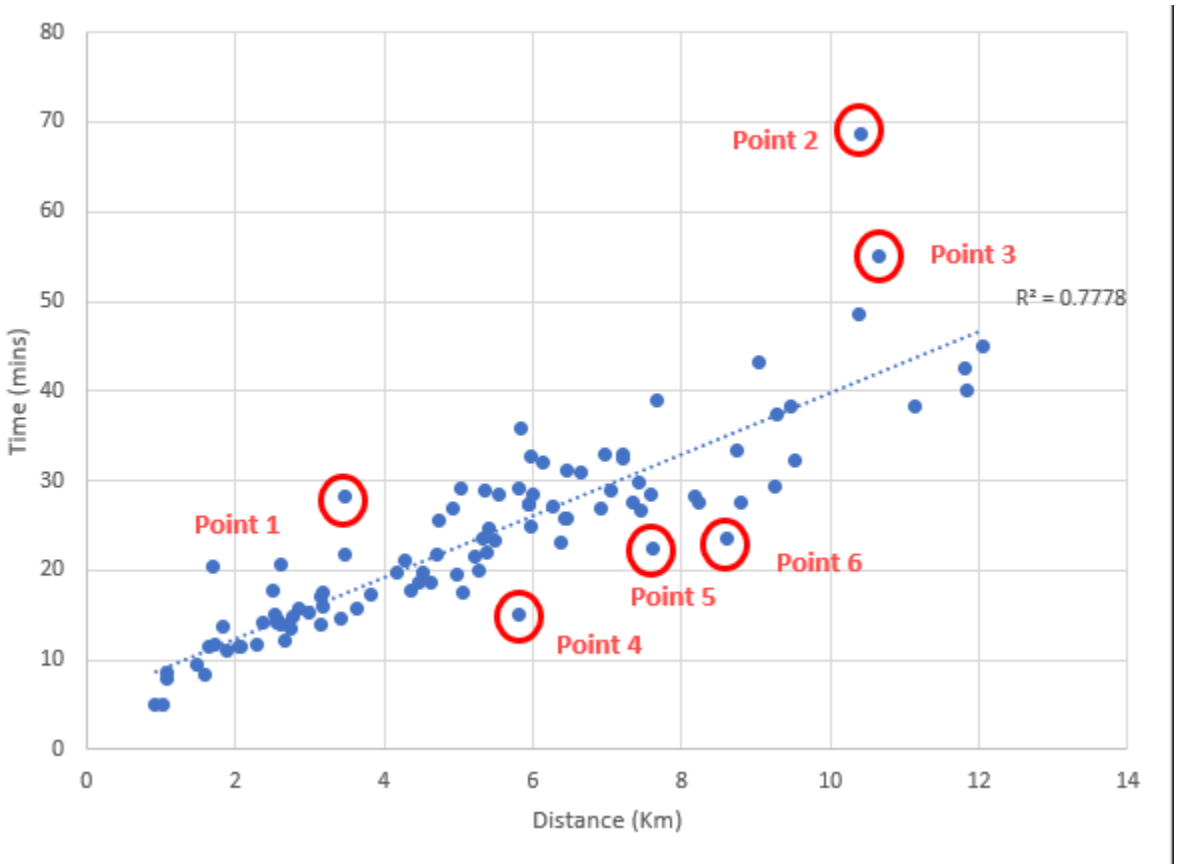


**Figure 8.3: Scatter plot chart showing travel time by distance to District Centres. Source: Author created using date from GMAL (2019)**

The circled points have been listed in table 20 and will be further analysed in the following sections.

**Table 20: Scatter plot points for further analysis. Source: author**

| Point number | Post code group | District | GMAL (time) | Regression estimate | Residual | Included/Excluded |
|---|---|---|---|---|---|---|
| 1 | M16 | Trafford | 28.31 | 17.49 | -10.8 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 2 | M44 | Manchester | 68.7 | 41.3 | -27.4 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 3 | OL14 | Rochdale | 55 | 42.1 | -12.9 | • Included<br>• Journey time slower than predicted by the regression<br>• Under performer |
| 4 | SK13 | Ashton under Lyne | 15 | 25.6 | 10.6 | • Excluded due to lack of available journeys |
| 5 | BL0 | Bury | 22.5 | 31.6 | 9.2 | • Included<br>• Journey time quicker than predicted by the regression<br>• High performer |
| 6 | M27 | Bolton | 23.6 | 35.2 | 11.6 | • Included<br>• Journey time quicker than |

| Point number | Post code group | District | GMAL (time) | Regression estimate | Residual | Included/Excluded |
|---|---|---|---|---|---|---|
| | | | | | | predicted by the regression<br>• High performer |

#### *8.7.4.1 Point 1 M27 Analysis*

Point 1 sits on the border of the Salford/Bolton districts, inside Salford. The district has a train station with direct routes to the city centre. Alongside this, direct bus links with relatively few stops appears to enable travellers to cover the 8.6km distance in a shorter time than expected. Due to its close proximity to the city centre, the area benefits from frequent services, provided by several operators, with services to the district centre every 10 minutes from some operators. This location is a good example of one with high connectivity to several locations, including the district centre and Manchester city centre.

#### *8.7.4.2 Point 2 SK13Analysis*

Sitting on the edge of the city region, and with some postcodes outside the border, SK13 is a predominantly rural location. Due to the lack of available routes, this location has been excluded from further analysis as whilst the GMAL and regression estimates provide an expected journey time based on the factors incorporated into the model, no journey can be planned using journey planners. When considering public transport alternatives, the journey can be undertaken by bicycle in an hour, or by taxi in 26 minutes, which is similar to the regression estimate.

#### *8.7.4.3 Point 3 BL0 Analysis*

BL0 is an area within the district of Bury, which includes Edenfield and Ramsbottom towns. Accessing the district centre (Bury town centre) can be undertaken via bus, with services operating every 15 minutes. A direct route is available, lowering the time requirements for interchanging and waiting for ongoing services. As such, travellers are able to access this district centre from BL0 at a quicker speed than estimated for the distance. The walking legs at either end of the journey almost double the time, with the walking time from BL0 to a bus stop along the route adding around 15 minutes of time to the journey.

#### *8.7.4.4 Point 4 M44 Analysis*

Point 4 is located in the district of Trafford. The postcode sector includes the towns of Irlam and Cadishead. The difference between the GMAL model estimate and regression estimate is

significant, however, this could be attributed to the range in potential journey times. When considering the travel options available, journey planners point to routes and modes that range in journey time from 45 minutes to 1 hour and 10 minutes, depending on the route. A key challenge for the area appears to be accessing the main transport links, with at least 23 minutes of walking included in any of the journey planning options available. When able to access a transport link, both trains and buses are available.

#### *8.7.4.5 Point 5 OL14 Analysis*

As highlighted in the previous section, OL14 sits to the north of the city region, which the majority of the postcode area outside of the city region boundary. The postcode sector benefits from a train link to Rochdale district centre. However, due to the postcode sector area being large, travelling from the centre point to the train station requires a 46-minute walk. There are no alternative options presented using public transport, highlighting a lack of connectivity generally with the traditional transport hubs in the area. However, the same distance can be travelled in 23 minutes by bicycle. Similarly to what was mentioned in the previous section, first and last mile transport, particularly flexible transport options could enable residents and visitors to access the transport hubs in the area.

#### *8.7.4.6 Point 6 M16 Analysis*

M16 is based in Trafford and incorporates some major destination points in the city centre, including Old Trafford football and cricket grounds. It also includes the town of Whalley Range and borders the regional centre. Due to its close proximity to Manchester city centre, and the lack of definable district centre in the district of Trafford, the model has calculated Market Street Manchester (the Manchester district's centre and regional centre) as the nearest district centre. The journey can be undertaken several ways by public transport, including using trams and buses. As a key destination point, it is well served by public transport, however due to the circuitous routing of the journeys posed by the journey planners, the time taken to travel the relatively short distance of 3.4km is longer than the model would typically estimate for the distance. The proposed public transport journeys are estimated to take between 28 and 32 minutes. Alternatively, the journey could be undertaken by bicycle in 18 minutes or by walking in 48 minutes.

#### *8.7.4.7 Thoughts on district centres*

The R-squared is 0.778 as highlighted in figure 8.3. This highlights a strong relationship between the two variables used in the analysis. However, when considering the district centres, some districts do not have defined centres, transport interchanges and hubs may not site within

the district centre, or the nearest centre may not be the district in which the postcode sector is located. Accessing a local hub of shops and transport links may require orbital or radial travel, depending on the proximity. In this case, the key decider on which centre is most appropriate was travel time, as opposed to distance or speed of travel. This may not be in line with traveller perceptions around which district centre to visit, which may be determined based on local cultures and/or preference for available resources in the district centre. The role these destinations play in the city region will depend on both the city region vision for the future and the individual district strategies for future growth and investment. How transport can facilitate access to these centres would need further investigation around the role in which they play in city region development in future. Alongside this, the role of traditional modes and new or active roles in accessing these destinations could provide interesting case studies for MaaS, as each location will have unique requirements.

## 8.8 Discussion of Analysis

Several areas of interest have emerged in the analysis undertaken, using the points identified in the scatter plot charts. The following sections detail these areas of interest further.

### 8.8.1 Radial and orbital travel

Several routes, including ones that travellers could take into the city centre, incorporate orbital travel. Greater Manchester has a well-developed radial transport network, with corridors feeding the regional centre's employment, education, and leisure destinations. Orbital travel has been recognised by TfGM (2017/2021) as having a role in the city region but defining how transport can best serve orbital routes is an ongoing challenge (TfGM, 2017/2021). Smith and Barros (2021) argue that a robust orbital public transport network is an essential element of an equitable and compact city. Alongside this, Smith and Barros (2021) argue that upgrading centres outside the inner-city areas is vital to creating diverse subcentres of activity around a major city centre.

However, if orbital travel requirements relate to shopping and/or leisure, in place of commuter travel, then understanding the types of transport required would take additional consideration for each area, as each would have unique requirements (Smith & Barros, 2021). Flexible and active modes, along with on-demand modes, could play a key role. However, organisation and delivery of services and infrastructure investment (if required) could pose a challenge.

### 8.8.2 The impact of interchanging

Following the above analysis, interchanging is noted as having a significant impact on some journeys. This relates particularly to areas which take several stages to access either a hub that offers more direct transport links or where travellers are required to take multiple short trips as no other links are available. In a study interviewing potential public transport users, interchanging is noted by Hine and Scott (2000) as being a barrier to uptake of public transport, particularly due to poor reliability of transport (particularly bus services), the lack of time to change between services and the lack of efficiency around interchanging, in particular the reliability of services and the need to move within or between transport points, impacting delays. For journeys noted in the sections above, some require multiple interchanges across several modes. If this acts as a detractor, how to either reduce the number of interchanges required or to improve the efficiency and reliability of interchanging will be essential to offering an attractive experience for users. MaaS may have a role to play in this area, particularly around the coordination of transport services.

There also appears to be some opportunity for new methods of delivering first-last mile transport options. First-last mile transport is the part of the journey that includes the distance travelled in advance of, and after, a traveller uses public transport (Park et al. 2021). Noted by Venter (2020) as a key part of the overall experience of travellers, first and last mile transport is a growing and challenging area of public transport research and professional interest. Park et al. (2021) argue that the first and last mile has a significant impact on the perceived "burden" of public transport use, and whilst being a large part of the overall journey, is a frequently ignored or under-played component. In this instance, first-last mile transport could offer residents and visitors links to larger transport hubs. Hussain et al. (2021) note that there are several emerging transport modes that offer travellers a range of options for first/last mile transport, however these options are not typically integrated into the overall network operations and planning. Alongside this, whilst some modes are available in urban areas, in more rural locations the availability of options is typically lower as it presents both a less attractive commercial option and/or a potential subsidy burden for transport and local authorities. How first/last mile transport could be provided in some of the areas highlighted will depend on several factors, including the modes most appropriate for the trip purpose, type of traveller, frequency, and volume. Whilst some of the more traditional modes could be challenging to provide, some active travel and new transport modes i.e. electric scooters (pending regulatory

approval) could offer travellers the ability to move to between larger transport hubs and residential, employment, education, and leisure destinations.

### 8.8.3 "Local centres" and travel patterns

The nearest district centres were used in the analysis, to understand access to goods and services outside of the city centre. Whilst the nearest district centre was used, this may not be the district centre of choice for some residents and visitors. Choice of location can depend on several factors, including personal preference and cultural reasons. As such, travellers may choose to visit a location further away or one which is harder to reach by public transport. Understanding the cultural links between residents, visitors and district centres may help transport providers and authorities plan and manage public transport provision. However, there may also be scope here for MaaS to offer insight into traveller preferences, based on where they nominate as their preferred local "hub". This data collection may enable transport operators and providers to understand need and traveller preferences in more detail than what is currently available. Having considered the outputs of this chapter, the following section details the limitations of the analysis and ways the limitations could be overcome in future studies.

## 8.9 Limitations

There are several identified limitations with the data and methods chosen for this analysis. These limitations include possible errors in the GMAL model itself, and the approach to analysis conducted. Alongside this, a limitation of the journey planner tools used is also considered.

With regards to the GMAL model, there are two key areas that may have impacted the data during the analysis:

1. There may be errors in the model itself, in the journey distance and/or time assumptions. The model itself is not tested, and it is not clear where the journey time assumptions from the model come from.
2. Through the process of aggregating postcodes, the model may have become less accurate. When aggregating the data, to make consideration of well and poorly connected areas easier for analysis, if the postcode area is large the resultant postcode sectors could contain different journey times and therefore the analysis may not be representative of all postcodes within the postcode area.

Alongside this, the approach used only considers time, speed, and distance. In reality, there are several elements that impact traveller choice (as highlighted at the beginning of this chapter).

In reflection of this, generalised cost may be a better determinant of how people would choose to travel as it takes into account a wider range of considerations, including ticket pricing, preference of mode and the reluctance to interchange. Whilst the GMAL model takes into account time taken for interchanging and its impact on journey time overall, it does not consider whether the act of interchanging itself would be a deterrent on the choice of journey.

Similarly, journey planners are limited in how trips are determined, frequently choosing routes that may be a longer distance or take a longer amount of time. This is typically true as public transport and active travel modes are frequently separated, therefore bicycles and other active modes are not considered for the first/last mile elements of journeys (Paul et al., 2016). Alongside this, to avoid longer walks which may be preferable to some travellers, journey planners suggest multi-leg journeys i.e. a short walk, a bus trip, and another short walk, in place of a slightly longer walking trip (Paul et al., 2016). How journey planners make recommendations for trips, including multi-leg journeys, needs wider consideration.

With regard to the district centres: some districts have very loosely defined district centres. As such, a specific point of interest had to be chosen for the districts of Salford and Trafford, which may not be the same point residents and visitors would choose to travel to when considering visiting the location they believe to be the district centre.

Finally, journey planner routes may have been affected due to the COVID-19 pandemic. This may include a reduction of available routes, a reduction in frequency of services and/or a change in availability of services over time i.e. fewer services available during peak or off-peak hours. Whilst the GMAL model will not have been affected (the latest release was published before the pandemic), the comparison with journey planners may have been impacted.

In terms of how these limitations impact Greater Manchester's ability to develop a MaaS system: any system will be developed using largely existing data due to the cost and time constraints of seeking out new data in an area as large as the city region. The limitations found here will impact TfGM in the same way. This will mean additional sources of data will be required to ensure any analysis and evaluation conducted is an accurate and fair representation of the current system.

## 8.10 Chapter Conclusion

As noted in this chapter, there are several areas with gaps in transport service and infrastructure provision. These gaps could be filled using innovative methods of transport delivery and new

modes that support additional flexibility. How MaaS could fill these gaps would depend on the service designed for the area but could include options noted by interview participant 11 (2020) such as community owned services and services that suit semi-rural areas such as on-demand options. In order to determine whether MaaS could fill these gaps, additional work on trip volume, purpose and frequency would be required to better understand what role different modes could have in filling these gaps. As noted in chapter two, a gap in knowledge relates to the many of the benefits of MaaS that are still assumed and as such it would be easy to make similar assumptions here that new and novel modes may fill the gaps in provision in these location, when more traditional modes such as on-demand transport provided through Local Link services, alongside high-quality cycling infrastructure may be more appropriate. The next chapter brings together the insights gained in the three results chapters and considers how these insights fill identified gaps in MaaS knowledge.

# 9 Chapter Nine: Discussion

This chapter brings together the insights gathered in the previous chapters and demonstrates how the research questions have been answered. As a result of this research, several elements have contributed to the discussion of MaaS as an evolving transport planning and operational concept. This chapter highlights these areas and how they fit within the overarching discussion of MaaS and transport planning at professional and academic levels. The chapter is composed of the following sections:

- A summary of the aim and research questions that have guided this study;
- The knowledge gaps identified and how this research contributed to filling them;
- A discussion of the research outputs in relation to the research questions; and,
- A summary of the original contribution to the MaaS debate.

Following this chapter, the conclusion will highlight the limitations of this piece of work and areas for further research.

## 9.1 A summary of the research aim and questions

As noted in chapter one, the following aim was developed to guide the research:

> *The aim of this research is to critically investigate the potential impact of 'Mobility as a Service', using Greater Manchester in the UK as a case study, to identify relevant policy application opportunities, examples of transport planning changes, and mechanisms to overcome barriers to the introduction of sustainable MaaS system.*

Alongside the aim, five questions were developed and were central to this piece of research:

1. What are the key challenges and barriers to the development and implementation of a MaaS system?
2. What benefits may a MaaS system bring to cities or city regions?
3. What best practice, with regards to considering and implementing innovative transport measures, exists from cities worldwide?
4. What are the key transport challenges and gaps in Greater Manchester?

5. How could MaaS support the reduction or removal of transport gaps and challenges in Greater Manchester?

These questions have guided the study and provided focus throughout. Each question was developed to relate key areas of MaaS, transport policy and gaps in knowledge and capability. The following section will detail the insights gained through each of the results chapters and will highlight how each chapter has contributed to the overall aim of the research and the wider body of MaaS knowledge.

## 9.2 Gaps identified and this research

Having commenced in 2016, this research was able to draw on an enthused professional and academic pool of contributors to the MaaS debate. Whilst the term was developed earlier, it was throughout the period between 2013 and 2019, that MaaS was explored more fully through the use of public trials (including notable trials such as UbiGo and NaviGoGo), the application of significant grant funding in the UK, Europe and globally, and ongoing academic debate. Whilst the trials and debate have yet to result in a large scale, sustainable system being implemented, this research was still able to benefit from a rich discussion, as highlighted through the literature review and semi-structured interviews undertaken as part of this study.

Several gaps in knowledge were identified at the beginning of this research which present clear barriers to the implementation of MaaS:

- The role of the public and private sectors in a sustainable MaaS system;
- The scope of a MaaS system, with practical consideration for transport authorities and operators i.e. a single city, a city region, or a multi-region approach;
- The potential impact of a MaaS system on traditional public transport usage and other assumed benefits; and,
- Scenarios for MaaS implementation at a sustainable level.

Whilst identifying these gaps proved useful to this research, the gaps identified were not themselves unexpected when considering how a concept like MaaS has developed over time. In reality, these gaps exist for a reason: without a sustainable system in place at a large enough scale, and with each trial focusing on different aspects to test, there is a lack of available data to support decision-making at an operational and strategic level. Alongside this, data from trials is usually shared only through project reports, and not at a granular enough level. This prevents analysis by the wider academic and professional community of how trial participants have interacted with any system being tested. In the absence of enough data to support evidence-

based decision making at local and national levels, several areas of the MaaS debate remain entirely theoretical. In these instances, academic and professional debate are the main way to add to the depth of knowledge. Emerging conceptual viewpoints along with changes in transport requirements as a result of an ongoing global pandemic, have led to a complex landscape for planning and operating transport services in cities, and have exposed the lack of resilience to unforeseen challenges and general state of flux imposed on cities in recent years (Muldoon-Smith & Moreton, 2022).

Each chapter in this research has offered new insight into the MaaS debate and contributed to answering the research questions and adding to the existing knowledge gaps identified, by offering new or greater depth of understanding into existing information on MaaS. The literature review (chapter two) highlighted gaps in knowledge, providing guidance to the data collection and analysis phase of the research. In-depth interviews (chapter six) provided insight from professional and academic actors related to transport planning and/or MaaS developments. A policy analysis chapter (chapter seven) critically analysed policies from thirty cities, investigating policy views on the key components of MaaS identified by the interview participants. This chapter also compared findings from these policies with the Greater Manchester 2040 Transport Strategy, to determine how Greater Manchester's regional transport strategy compares with the transport policies of thirty innovative cities. Finally, an investigation into current transport practices in Greater Manchester was undertaken (chapter eight), to better understand current transport choices by residents and visitors, along with where MaaS may fill existing gaps or improve transport access or provision. Through these data collection and analyses chapters, insights were gained that add to the MaaS debate, focusing on the areas where gaps were highlighted in the literature review, ensuring the knowledge gained is both original and provides valued insight for academics and professionals involved in planning and developing MaaS systems.

## 9.3 Research outputs in relation to the research question

This section will review each research question and highlight how the research has contributed to answering the question and adding to the MaaS debate.

### 9.3.1 What are the key challenges and barriers to the development and implementation of a MaaS system?

Several challenges to the development and implementation of a MaaS system were highlighted in this study. A key challenge identified is what a MaaS system may contain, and what its main focus will be on (Hensher, 2017; Jittrapirom et al., 2017). Both academic literature and

interview participants noted that the scope of a system will rely on the proposed "mission" for MaaS in an area. However, whilst this may sound simple to define, it highlights that many of the assumed benefits of MaaS rely on a wide-ranging mission to change how travellers choose to access, pay for, and use a transport system, when in reality, the challenges each area needs address may not result in some of the benefits being realised.

Access to data was noted as a challenge by interview participants. This was the case for systems within a single city, country or across a system of countries (such as the European Union). With interview participants noting that a large proportion of travel is typically undertaken locally, and is therefore quite predictable, sharing data of existing patterns may enable the development of a system locally, even if it is initially focusing predominantly on shorter, local trips. However, the implications for data protection, commercial agreements regarding the collection and use of data and public trust in data security were all raised as potential barriers to wider data sharing by interview participants. Similarly, the policy analysis highlighted cities are increasingly recognising the value that may be added by better using data available to them, but accessing and securing data presents new challenges cities have not faced before on a large scale. Alongside this, countries which have made steps towards improving access to data and transport information, backed up by regulatory changes to open up transport systems to new processes, are still facing challenges with the uptake of MaaS systems being lower than anticipated, preventing a system being operated at scale with a wide range of transports available. This highlights an ongoing challenge with the value proposition that considers real challenges in specific locations, so any potential benefits are related specifically to those challenges. Whilst some areas are broadly accepted, such as integration of services and infrastructure moving towards a greater use of digital services, without defining the specific problem to be solved, planners and policy makers are unable to dig deeper into how these benefits could be realised and who they will directly and indirectly impact. In order to define the problem, planners could look towards their local populations to ensure any problems identified are relevant and meaningful to transport users (Brown et al., 2022).

It was noted by several interview participants that MaaS is currently stuck at trial stage and struggling to transition into a sustainable system operating at scale. For MaaS to make this transition and be accessible to a wide range of people, additional work is required in several areas. As noted by interview participants, several potential scenarios for implementation are being considered, and some are being trialled in Europe. However, in this case the public value ecosystem, which incorporates a mixture of public or private actors, and offers value for all

players, is reliant on local and regional buy in. In this type of system, there is a balance between rules set to enable the achievement of policy goals and noted commercial opportunities, with a strong role for the public sector. MaaS has acted like a wakeup call for the transport sector, and as such has allowed a range of potential scenarios for implementation to be debated.

Finally, the roles public and private organisations would play in a MaaS system is noted as a significant barrier to implementation. As noted by interview participants and academic research, some operators within the transport environment are hopeful that the public sector will choose to take an active role that could provide leadership for private operators. The public sector could encourage trust and transparency in a system and offer a level of equity between operators. This corroborates with ideas noted in academic literature and detailed in chapter two, specifically around how any agreement on roles and responsibilities will impact everything within the system itself, ranging from accountability for operational reliability to payment processing and data security (Ultriainen and Pollanen, 2018; Karlsson et al., 2016). Whilst unrelated to MaaS, this type of leadership at regional level has been displayed in other ways in Greater Manchester to date, particularly through new schemes that relate to active travel i.e. the Bee Lines network: a cycling infrastructure and policy proposal, to guide future investment into highways improvements in future (TfGM, 2018). This proposal highlights how a transport authority can provide the framework, policy goals and intentions for an area whilst also inviting wider contribution to achieve the goals that have been set.

Whilst interview participants noted the importance of the public sector taking an active role, many did not believe these organisations were dynamic or innovative enough to take on the role of the overall operator of a MaaS system. Managing and processing large, real-time data sets was noted in particular as an area where private organisations, such as Uber, have significantly more experience. Alongside the issue for creating systems to undertake this task, the regulatory requirements that would impact public sector organisations (but not private ones), specifically around fare competition standards and service-traveller allocations, were also raised as potential barriers by interview participants.

### 9.3.2 What benefits may a MaaS system bring to cities or city regions?

When discussing the potential for MaaS in cities, several assumed benefits are frequently cited. These typically focus on outcomes that would benefit individual users of the system, including personalised mobility, reliable and seamless transport and the integration of transport ticketing and services (Mulley et al. 2018). Alongside this, wider benefits such as reductions in emissions and congestion are also frequently noted (Mulley et al., 2018; Ultriainen and Pollanen, 2018).

However, these potential benefits are based on assumptions of how a system could work. Without a system in place that policy makers and transport planners can learn from, these benefits remain an assumption.

Assumptions regarding a shift to the use of public transport and active travel are often cited as core benefits of a MaaS system. However, interview participants noted that there is no reason for this assumption, and that in reality previous research has highlighted that individuals make changes when services are changed or introduced, not on the basis of information being shared in a new way. Many of the assumed benefits of MaaS rely on a wide-ranging mission to change how travellers choose to access, pay for, and use a transport system. Both academic literature and interview participants noted that the scope and benefits of a system will rely on the proposed "mission" for MaaS in an area.

Interview participants also noted that in order to attract users and retain them, a suitable range of services must be offered. In doing this, users will be provided with a wider range of accessible services than they may have previously been aware of and may therefore be enticed to try something new, potentially resulting in lower private car usage. Several interview participants noted that public transport is likely to be the backbone of a MaaS system in areas where there is already provision for users. This corroborates with several of the city policies analysed, which noted the importance of public transport usage in reducing some of the chronic challenges associated with private vehicle use (Greater London Transport Authority, 2018; San Francisco Municipal Transportation Agency, 2018).

Interview participants also argued that service provision is not evenly spread and even in relatively urbanised areas in Greater Manchester, services can be fragmented and poorly operated. This is a noted issue in the transport policies analysed, with several recognising that the impacts are typically seen in areas with low-income populations and minority ethnicities (Boston Transportation Department, 2017; Greater London Authority, 2018). In this case, offering an application that improves access would not be sufficient without also considering and improving wider transport operations. However, transport policies suggested improved information and the utilisation of better technologies to improve operational efficiencies could also positively impact the range of modes available in more areas (City of Melbourne, 2019). When paired with encouraging the use of active modes, such as walking and cycling to bridge gaps, cost effective options could also be offered that are suitable for short, cross-urban trips

(City of Dallas, 2006, Singapore Land Transport Authority, 2019; Syndicat des Transports d'Île-de-France, 2015).

Whilst a MaaS system may offer benefits, it was noted that service provision is only one element of a transport network. For many benefits to be realised, infrastructure investment would also be required. This is particularly true in the case of cycling infrastructure, alongside infrastructure for public transport. Alongside this, digital literacy was noted by interview participants as a key element for potential users to access the benefits of MaaS. IT literacy would present a particular challenge, regardless of modes of transport available, if the only way to access the system was via an application.

### 9.3.3 What best practice, with regards to considering and implementing innovative transport measures, exists from cities worldwide?

Whilst no city has an ongoing, sustainable MaaS system that is available at scale to users, many cities are developing and implementing innovative measures to improve access and use of transport, transport and transport service planning and wider placemaking. With this in mind, there are several areas of best practice which show how a city can utilise innovative measures to improve transport for resident and visitors.

Firstly, changing how infrastructure is used can improve overall system management of a transport network. As noted in section 7.8.3, managing parts of the network that could be considered "dynamic" offers an opportunity to use spaces in a new way. In particular, the use of temporary spaces to create attractive places for pedestrians and cyclists can offer cities a way to better utilise space whilst planning for longer term developments including increasing public transport infrastructure. Leisure, education and green spaces could be created that offer better connections and instil a neighbourhood affect within different city areas, alongside seasonal events such as festivals, markets and street parks.

Creating and using a Transit Orientated Development (TOD) plan was also noted by cities as being a key foundational element that allows future innovation and creative development to take place. As highlighted in both chapter two and chapter seven, TOD involves bringing together residential, commercial and transport planning to ensure current and future transport capacity can support growth. Through integrating these planning elements, it establishes a clear link between investment and a city or urban "mission" for growth and development over time. As new innovations emerge that can support this mission, they can be developed and adopted within the context of an established plan and vision for the city area.

The creation of specific locations to be the focus of testing and trialling innovative measures was noted in the city policies analysed. For those using or developing these spaces, implementing a system to support creativity through the use of technology and experimentation was highlighted as being central to these areas. However, wider regional, local or national support may be required to enable these areas to maintain an open mind in the face of potential regulatory or policy barriers. Ways in which risks could be managed were noted, but failure was highlighted as something that should be welcomed as a possibility or outcome of testing innovative measures and not a reason to avoid adopting them.

Finally, the use of technology was noted at length in the city policies analysed, with over 239 references made to opportunities for technology in transport and urban planning. Many assumptions were made around the use of technology, and the potential benefits it could bring, however many references to technology focused on how it could support clear goals and objectives for city development. This was particularly the case with regards to providing more and better presented information to transport users, allowing them to access ticketing and payments in new ways, and supporting new and novel transport modes as they emerge.

### 9.3.4 What are the key transport challenges and gaps in Greater Manchester?

Chapter eight highlighted several areas relating to accessibility of transport in Greater Manchester that present a challenge to the city region's plans for integration and use of new modes and technologies:

- Whilst orbital travel may not be as important as radial travel for commuting, those who undertake orbital travel are at a disadvantage with regards to mode choice, frequency, and interchanging. Alongside this, understanding how orbital travel relates to non-commuting trips is an area for further development, as the times and types of transport, and the complexity of trips would be different
- Interchanging is having a significant impact on some journeys. This is particularly evident in areas which do not have a transport 'hub' and instead travellers must first travel to a hub to access a wider range of services and modes. As highlighted by Hine and Scott (2000), interchanging does impact uptake of public transport as it creates concerns around reliability and service frequency. The role of on-demand and community transport options were of interest here, as having the potential to fill gaps which cannot be filled with traditional transport services

- Availability of modal options was lower when moving away from the regional centre, particularly in areas which are far from, or not have, a clear district centre or hub.

These points highlight that whilst Greater Manchester has a well-developed transport system with several modes available to users, integrating these modes and ensuring wide availability is still a challenge. This would impact the city region's ability to deliver MaaS as integration and reliable transport are often noted as key components (Arias-Molinares & Palomares-Garcia, 2020; Finger et al., 2015).

Currently, the transport network in Greater Manchester is a complex system with modes that are not always planned with the view to offering users an integrated experience. Considering each mode, and the diverse range of views each resident and visitor has on each mode, may impact the uptake for any system developed and implemented. How a system is developed, tested, and then altered if parts prove unsuccessful will impact how sustainable a system is able to be in the long-term. Alongside this, the design and development of a system would need to meet current and future policy goals, and new national, regional, and local targets for emissions reductions. Greater Manchester is making some moves towards rectifying these issues, as highlighted in chapter five, with the widening scope of the Bee Network to include integration of public transport with active travel modes (TfGM, 2022).

### 9.3.5 How could MaaS support the reduction or removal of transport gaps and challenges in Greater Manchester?

As noted, several gaps and challenges exist within the transport network in Greater Manchester. Whilst some progress has been made there are several areas that require further consideration in advance of a MaaS system being implemented. With regards to Greater Manchester, two elements of the 2040 Strategy (TfGM, 2017/2021) are of particular importance when considering progress towards a MaaS system:

1. **A clear recognition of the impact new and evolving technologies are having and will continue to have on urban planning and mobility**. As noted in section 7.3.1 of chapter seven, technology is considered in several ways in the 2040 Strategy. TfGM (2017/2021) noted that an increased use of technology could mean the development and delivery of new and more opportunities for integration the transport network infrastructure. Alongside this, TfGM (2017/2021) noted that technology also provided new ways of improving information distribution, particularly when promoting different

mobility options including active and sustainable modes. Both of these areas are noted by academics, with Ultriainen and Pollanen (2018) questioning how reliance on these technologies will work in areas with poor connectivity, low use of technology and technical barriers, and how reliance may impact the ability to create an equitable and accessible transport network as part of a MaaS system. Similarly, interview participant 7 noted that there is an emphasis on technology being used to solve long-term challenges in urban areas, when there is little evidence locally that the provision of some new technologies (such as information applications) has an impact on the choices individuals make when there are gaps in transport service provision for public transport modes.

2. **Transport integration and coordination with wider range of travel needs is required across services and infrastructure in the city region.** TfGM (2017/2021) noted the importance of integration as a key aim of the strategy document. Whilst the theme largely focuses on the public transport network, there is recognition of the broader opportunity to integrate wider services and infrastructure. Integration is a key element noted in literature and research considering MaaS, particularly with regards to the integration of traditional transport options with new, novel, and active travel modes. However, whilst it is a key aim to develop network integration, and the strategy is focused on long-term development (up to 2040), several parts of chapter eight, highlighted noted gaps and areas of fragmentation in the transport network. It is unclear from the 2040 Strategy how these gaps in provision and areas with poor integration will be improved in the short or long-term. In contrast, section 7.9 in chapter seven detailed initiatives being undertaken in some cities to combat fragmentation in transport networks, including offering access to active modes, cost effective options for cross-urban trips, and the creative use of open spaces to offer a sense of place in areas in-between transit points (City of Atlanta, 2017; City of Dallas, 2006, Singapore Land Transport Authority, 2019; Syndicat des Transports d'Île-de-France, 2015).

To develop a sustainable MaaS system locally, for Greater Manchester residents and visitors, the vision for MaaS in the city region would need defining to meet strategic and policy goals. in order for MaaS to be considered at a strategic or funding level, the "mission statement" would need defining and how the system may be structured to deliver this mission statement would also need clarifying. Whilst the city region is experiencing several challenges that other cities are currently facing (congestion, poor air quality etc.), the opportunity for Greater

Manchester to move MaaS forward may lie in their ability to define a MaaS system that would be focused on benefiting the unique needs of Greater Manchester residents (Brown et al., 2022). Alongside this, utilising a way of gradually implementing a MaaS system may allow for a more gradual and less disruptive planning and operations. Structuring the implementation of MaaS to conform with levels or categories is not a new recommendation.

MaaS levels could be achieved to support the development and implementation of MaaS using existing systems. This approach would enable Greater Manchester authorities to utilise existing structures and operational systems to implement MaaS over time. TfGM (on behalf of the Greater Manchester Combined Authority) currently manage the Metrolink operational and maintenance contract (currently contracted to Keolis Amey Metrolink), they own all bus infrastructure assets including stops and interchanges, and as the city region is progressing with implementing the Bus Services 2017 Act, the city region transport authority will own and/or manage a significant quantity of the public transport in the Greater Manchester. With this in mind, the city region is well placed to be leading the development of a MaaS platform, if it meets their strategic goals. Alongside this, new modes and operators could be invited to join the platform. This concurs with interview participants who noted that whilst some cities would not possess much leverage to shape MaaS if it is being developed by private organisations, those that do possess leverage can take a stronger role in defining the future direction of MaaS.

## 9.4 Original Contribution to the MaaS debate

This research has brought together several elements that have added to the MaaS debate, with a focus on transport planning. In particular, bringing together a wide range of viewpoints via the in-depth interviews, alongside the critical policy review of cities at the forefront of innovation and analysis of local transport patterns in Greater Manchester, has led to the generation and analysis of new insights that add to continuing development of MaaS as a transport planning concept. There were three areas specifically where this study contributed to original knowledge, alongside the data gathered and analysed to fill gaps identified in the literature review. These three areas are:

1. The use of mixed methods in this type of research: existing literature highlights studies which utilise either qualitative or quantitative methods in relation to the topic of MaaS. However, by combining insights gained from in-depth interviews, document analysis and analysis of transport data patterns in the city region, this study was able to consider MaaS from a several angles and the outputs of each type of method used added value to the others.

2. The use of a case study location: as MaaS is without a clear and agreed definition, studies often focus more on the topic of MaaS itself, or on one or a combination of elements that relate to MaaS i.e. the technical, political and commercial perspectives, as opposed to how it might work in a specific location. By incorporating a place into the study, it anchored the research and related implementation challenges and potential benefits to a specific location (allowing for more debate on what impact MaaS may have)
3. The overall focus on practical outcomes, as opposed to theoretical debate: as the MaaS debate progresses, the conversation still revolves around the topic as a whole. By focusing on the practical outcomes, this study avoided becoming a purely theoretical piece of work and instead has incorporated points that would add guidance and aims to inspire conversation amongst policymakers.

### 9.4.1 Chapter Conclusion

This chapter has brought together the insights gained throughout this piece of research, considering the policy, regulatory and commercial considerations of MaaS. Firstly, through the interview responses and policy analysis, a better understanding of how cities could leverage their own local challenges through policy and regulatory development to play a key role in the development of a MaaS system was gained in chapter six. Chapters five and eight detailed areas in Greater Manchester where gaps in commercial service provision limit the ability of residents and visitors to access a wide range of services, and how MaaS may allow for the use of new and novel mobility modes, along with active travel, to fill these gaps in provision. Chapter six highlighted through interviews how the conceptual interpretation of MaaS currently relates strongly to personal and professional viewpoints around what needs a transport network should and could fulfil. Alongside this, the chapter highlighted that the assumed benefits of MaaS vary widely, and in some cases without relevance to the local area of implementation and its unique policy goals. Chapter seven showed that many cities and regions are considering innovation in relation to transport service and urban planning, but MaaS has yet to breach into public policy outside of a few limited cases. However, the key components of MaaS are frequently noted without being noted in relation to MaaS i.e. personalised and integrated transport services and information. Finally, chapters six and seven detailed how MaaS systems could be developed more gradually over time, using levels or alternative definitions to enable progress to be made that is both locally relevant and operationally sustainable.

# 10 Chapter Ten: Conclusion

To conclude, this piece of research has fulfilled the aim and research questions as set out in chapter one (Introduction). This research has addressed the policy, regulatory and commercial considerations relating to MaaS, through several the use of three methods which added value to this piece of work. A critical literature review has been undertaken, to better understand the current thinking and gaps in academic work relating to MaaS. The review highlighted transport challenges, the impact of transport challenges on individuals and cities, and where academic research and funded trials have added to the knowledge base with regards to MaaS (Bagloee, et al., 2016; Debnath et al., 2014; Hensher, 2017; Karlsson et al., 2016; Martinez & Viegas, 2017; Ultriainen and Pollanen, 2018). The review also noted several gaps in knowledge, noted in section 2.14, which this research aimed to contribute to filling.

Following the literature review, key MaaS actors and stakeholders were interviewed and provided valuable insight into the current barriers and challenges, and what the future opportunity areas may be in relation to MaaS, enabling a deeper exploration of the value MaaS could add to cities and town. An investigation followed which identified transport policies that incorporate elements of MaaS from the top thirty innovative cities in the world, to understand what policies could support the development and implementation of MaaS in the long-term. These policies noted areas where cities were at the forefront of innovation and the implementation of key elements of MaaS, including novel ticket and payment systems, new modes, and innovative ways of incorporating integration into a transport system (City of Atlanta, 2017; City of Chicago, 2019; Metrolinx, 2018; Singapore Land Transport Authority, 2019). Following this, transport patterns in Greater Manchester were analysed, to better understand current accessibility levels of public transport, where the key gaps in provision are and how current transport trends may influence future service and infrastructure investments. Finally, a comparison of MaaS components, identified by key stakeholders, and current Greater Manchester transport provision was undertaken in chapter nine to understand where the challenges may be to implementing MaaS locally, and to understand what areas are already utilising MaaS components.

By incorporating expert insight from key stakeholders, transport trend data from Greater Manchester, and policy initiatives from innovative cities, the research was able to consider current gaps and barriers, and also how policies being implemented today could either support or prevent the implementation of MaaS in the future as well. As highlighted in both the policy review (chapter seven) and the interview chapter (chapter six), MaaS itself may not come to

fruition but the key components are ones that have been part of transport planning and policy for some time i.e. transport integration, improving physical and digital accessibility to transport services, and increasing the availability of sustainable modes (Molinares and Palomares-Garcia, 2020; Smith et al., 2018; Ultriainen & Pollanen, 2018). However, several limitations have hindered the research and are detailed in the following section.

## 10.1 Limitations

Understandably, research undertaken to fulfil the requirements of a thesis must be bound within certain limitations. Firstly, the transport data used as part of the data analysis chapter included data from the previous Census, which was collected in 2011. To understand changes in transport patterns over time, Census data from 2001 was also used. Ideally, transport data from the 2021 Census would have been incorporated to understand changes in the past decade, particularly as academics have noted the change in the uptake of motor vehicles by the millennial generation. However, as the data is to be collected throughout 2021, and the transport datasets are not due to be released until late 2023, the research would have been significantly delayed. The datasets used (2001 and 2011) provided valuable insight but will not have included any travel pattern and choice changes since 2011. More specifically, any increase or decrease in sustainable transport patterns in Greater Manchester would not have been captured in these data sets. However, since additional datasets (GMAL) were used in combination with these, some insights were still drawn from the data available.

Secondly, there is limited data available for how MaaS would work in practice. Several pilot projects have been undertaken (as highlighted in chapter four), but no data has been made publicly available beyond compiled reports and statistics. Alongside this, the pilot projects are typically limited in size and scope, focusing on only a few transport modes to be used by limited numbers of participants and/or are only available in a small geographical area. Due to this, the majority of information available relating to MaaS is theoretical in nature. This impacts the ability of research to understand how it might work in practice, based on how it already works elsewhere, and causes any investigation to include several assumptions (Hensher et al., 2020).

Due to MaaS being largely theoretical in nature, the perception of what a MaaS system should contain, or deliver, is very subjective (Smith et al., 2018). This impacts everything from the definition to how a system could be developed, to the best way to implement it. The expert stakeholders provided valuable insight that offered new perspectives on MaaS, but those perspectives were impacted by their personal and professional experiences and resultant viewpoints. Due to this, creating an unbiased perspective was not, and could not be, possible.

Alongside this, the interviews took place prior to and at the start of the COVID-19 pandemic. With this in mind, there is limited discussion on how policies and MaaS may evolve post-COVID. Follow up interviews may shed more light on how perceptions of MaaS have changed and priorities relating to the future development of transport systems have shifted.

Thirdly, the policy documents analysed contained many components of MaaS but very few explicitly named the term. This may be a lack of awareness, or it may be an attempt to avoid naming specific concepts in an effort to keep options open and to avoid aligning city policy with a notable term at the time of publishing the policy. Due to this, many cities may have been aware of and considering MaaS, but it may not be evident in their city and transport policies. It is not possible, from the policy documents alone, to understand each city's perspective on MaaS and how it may be incorporated in city planning in future, even if these areas choose not to use the term "MaaS".

Finally, this piece of research was bound by the timeframes of a PhD. The concept of MaaS is constantly evolving and changing as new pilots are completed and new studies are published. However, a line had to be drawn on when to stop researching. As such, the author recognises that this thesis sits in a complicated landscape. However, the following recommendations build on the foundation created through this research and offer opportunities for areas for ongoing study.

## 10.2 Recommendations

Recommendations developed following this research are directed at city and transport planners, to support the move towards developing and implementing a sustainable MaaS system that meets the unique needs of residents and individuals in the local area:

- Adopt a citizen led MaaS co-design and engagement consultation, to better understand requirements of individuals in the city region. As noted above, one of the limitations of MaaS is the subjective nature of the concept. Without the involvement of citizens in designing, monitoring, and managing a MaaS system, the system developed may not include elements of value to all citizens and could instead be based on assumptions by transport professionals embedded in the industry with biased perceptions based on their professional experiences.
- Undertake critical analysis of how policy goals may differ from methods to appraise transport projects and how MaaS may fit within the methods to evaluate whether or not implementation is the correct fit for the city region. Currently, transport service and

infrastructure investment utilise methods that evaluate the economic benefits of an intervention. Policy and strategic goals may not align with economic benefits, due to the current limitations of the tools used to evaluate the potential benefits of an intervention. Improving existing tools or creating and using new tools may offer greater insight into the potential benefits of MaaS (and other) transport initiatives.

- Consider the development of MaaS "levels" specific to an area to support the gradual move to MaaS at a pace that allows for consideration of each element or key component. This will give transport authorities an idea of where they currently exist on the spectrum of MaaS but will also enable public policy makers to understand which areas are further forward in their development (and could provide recommendations to resolve challenges in other areas).

## 10.3 Future Research

Following the recommendations made in this chapter, ongoing research would be beneficial to monitor the future developments of MaaS. If a system is implemented in future, a study to understand the impacts it has would be of use to ongoing development. If a study is undertaken, a commitment to open data would benefit the academic community alongside an evaluation of the system. Currently, several assumptions on the benefits to be drawn from MaaS are frequently made (as highlighted in chapter two). These assumptions are typically based on theoretical studies, as opposed to being drawn on evidence produced from large pilots. As such, there is little evidence to suggest the assumptions are accurate. Without an established MaaS system in place to evaluate, limited progress can be made on the potential benefits and dis-benefits of a MaaS system. Once a system is in place, an evaluation could provide insight that could be used by other cities in the development of their own MaaS system.

Secondly, research into how co-design and community participation in the development of a MaaS system may provide useful insight. Currently, transport users are typically consulted in new schemes and infrastructure investments at very specific points in the design process. This limits the input communities can have and can result in the prevention of meaningful engagement with communities. By incorporating transport users and wider communities, including disability design groups, earlier in the process, the system to be designed could better reflect the unique needs of potential users. Co-design can often be seen as a challenging method of engagement; however it could also offer solutions that reflect community needs and meet future policy goals.

Finally, research to understand the impact technology might have on MaaS planning could provide valuable guidance on the development of a system. Currently, transport planning is undertaken by individuals, using modelling software tools to understand the impact of a scheme in advance of implementation. As the sophistication of Artificial Intelligence increases, how they could be put to use in highlighting particular pain points in a transport system and devising solutions could provide alternative options for the development of a MaaS system. Similar ways in which it is currently being used in other industries include generative design for building design that places a greater focus on users.

# 11 Chapter Twelve: Reference List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# Appendix A

| **Name** | **Role** | **Organisation** |
|---|---|---|
| Paul Thompson | Appraisal Lead | TfGM |
| Peter Abel | Volunteer | Friends of the Earth (Manchester branch)<br>Love Your Bike cycling advocacy campaign |
| Kevin Toye | Advanced Solutions Manager | TfGM |
| Dr Alastair McInroy | Senior Programme Manager | Technology Scotland |
| Dr Maria Kamargianni | Head of MaaS Lab | University College London |
| Suzanne Hoadley | Senior Manager, Coordinator Traffic Efficiency | POLIS |
| Kieran McMahon | Chief Executive Officer | Disability Stockport |
| Dr Graeme Sherriff | Research Fellow, | Sustainable Housing and Urban Studies Unit (SHUSU), University of Salford |
| David Smith | Lead Project Manager for the NaviGoGo Project | ESP Group |
| Steve Cassidy | Project Director for the NaviGoGo Project | ESP Group |
| Steven Russell | Innovation Manager | Stagecoach |
| Dr Rhiannon Hunt | Eco-Innovation and Circular Economy Expert | *Preferred not to say* |
| Ian Palmer | Head of Modelling and Analysis | TfGM |
| Dr Kate Pangbourne | Academic Fellow | Institute for Transport Studies, University of Leeds |
| Chris Taylor | Director | Mosodi (sustainable transport planning business) |
| Ben Walker | Head of Programme Management Office | Manchester City Council |

| Name | Role | Organisation |
|---|---|---|
| Dr Glenn Lyons | Professor | Mott Macdonald/University of West England |

Appendix B

# Information Sheet

# Policy, regulatory and commercial considerations for the implementation of a sustainable Mobility and a Service System

Before you decide whether you want to take part, it is important for you to understand why the research is being carried out and what your participation will involve. Please take time to read the following information carefully. Just ask if anything is unclear or if you would like more information.

**What is the purpose of this study?**

This research aims to understand more about the concept of Mobility as a Service (MaaS), how it came about and what it means in practical terms for transport planners, policy makers, related businesses and users. The research also aims to offer insight into the key components required to implement a sustainable MaaS system, including any relevant regulatory changes.

To ground the research, data on Greater Manchester travellers and transport planning is being used as a case study. By using this area as a case study, the research aims to retain practical relevancy and avoid being drawn too heavily into the theoretical space.

The key objectives of the research are:

- To investigate MaaS, including the core components and barriers to implementation
- To better understanding the opportunities, implications and limitations of MaaS
- To critically assess the key components of a MaaS system and whether these components could be practically implemented in a case study area
- To analyse the roles of different organisations in a sustainable MaaS system, including the responsibility of being the MaaS “provider” or “operator”

**What am I being asked to do?**

As part of the study, transport experts and leaders in MaaS are being interviewed to:

- Identify the key areas that may slow down or prevent the implementation of a sustainable MaaS system
- Give their expert opinion on the true benefits (if any) of a MaaS system
- Comment on the roles of public and private organisations in a MaaS system
- Provide insight on the methods in which a sustainable system might be achieved i.e. commercially viable versus subsidised

**What about confidentiality?**

In any published materials your identity can be described in the following ways:

- By name, organisation and role
- By role and organisation only
- By role or organisation only

However, your actual words may be quoted in text form. All data will be stored in a manner compliant with the Data Protection Act/General Data Protection Regulation, on a password protected computer, and locked in a secure office. You may request a copy of this data if you are interested.

**How will the data be used?**

The research will be written up in a thesis and presented at key transport conferences and may be published in peer-reviewed academic journals. It may also be used for teaching purposes.

**Please note that:**

- You can decide to withdraw from the research at any point
- You need not answer questions that you do not wish to
- If you withdraw from the study all data will be withdrawn and destroyed if you so wish
- This research has obtained ethical approval from The University of Salford ethics committee. If you have a complaint about the way in which the researcher has carried out the research you can contact the Director of Ethics, Professor Mohammed Arif at m.arif@salford.ac.uk.

**Thank You for your Participation**

You may contact us for any further information on:
**Clare Cornes, 07380446441, c.cornes@edu.salford.ac.uk**

# Appendix C

## *Consent Form*

**Title of Project:** Policy, regulatory and commercial considerations for the implementation of a sustainable Mobility and a Service System

**Name of Researcher:** Clare Cornes

*(Circle as appropriate)*

| | | |
|---|---|---|
| ➢ I confirm that I have read and understood the information sheet for the above study and what my contribution will be | **Yes** | **No** |
| ➢ I have been given the opportunity to ask questions (face to face, via telephone and/or e-mail) | **Yes** | **No** |
| ➢ I agree to participate in the interview | **Yes** | **No** |
| ➢ I agree to being tape recorded during the interview | **Yes** | **No** |
| ➢ I understand how the researcher will use my responses, who will see them and how the data will be stored and that I can withdraw from the research **at any time without giving any reason** | **Yes** | **No** |
| ➢ I understand that what I have said or written as part of this study will be used in reports, publications and other research outputs | **Yes** | **No** |

Finally:

| | | |
|---|---|---|
| ➢ **I agree to take part in the above study** | **Yes** | **No** |
| ➢ **I am willing to be contacted about further research on this topic but understand that this forms no obligation on my part to participate in further research** | **Yes** | **No** |

Signatures:

| | |
|---|---|
| **Participant** Name: | Signature |
| **Researcher** taking consent:<br>Clare Cornes | Signature |
| **Date** | |

# Appendix D

Please see the attached ethical approval letter