The use of Uberpool and its Relationship with Public Transport – A London case study

By

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Declaration

I hereby declare that the work presented is the result of my own independent work and was completed in compliance with the requirements and regulations of Edinburgh Napier University. This thesis or parts thereof have not been submitted for any other degree qualification.

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10th February 2022

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Date

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Abstract

The growth of novel forms of shared and non-shared ridesourcing services such as Uberpool and UberX, are nowadays a common feature of transport options in many cities globally (i.e., London). The rapid growth of these new services is creating challenges and opportunities for transport authorities and policymakers who so far have been slow to respond to policy and operational demands.

There has been much publicity about the possible effects of Uber services in London and ongoing debates among the transport authorities and other key stakeholders on how or if these services should be managed or regulated. However, with the absence of empirical data and a clear understanding of the current and future implications for traditional PT modes, the consequences of ridesourcing services on London's transport system are not evident. This study provides insights about the usage and user characteristics of ridesourcing services and how such services work with PT modes and explores the implications of Uberpool on conventional PT in terms of policy and operations.

The literature review for this study revealed that empirical research on shared ridesourcing has been limited, mostly because of limited data availability and as a result, effects on other modes such as PT are less understood. Current literature indicates some of the key factors in ridesourcing adoption, include the socio-demographic of users, convenience, cost, and general changing attitudes towards sharing.

The current literature on ridesourcing shows that most of the existing research the topic was primarily undertaken in a North American (i.e., the USA) perspective and the findings do not fully capture the policy, and operational issues that relate specifically to a European or UK context. Furthermore, shared ridesourcing is not adequately addressed in the current literature, particularly its impact and relationship with PT services. As such, it is not fully understood, and there is no consensus on how transport authorities and policymakers should deal with these new services. In addition, previous research mainly used a singular approach or considered only one stakeholder (i.e., the users or drivers) and thus did not fully consider the perspectives from all interested parties such as the users, drivers, service providers (TNCs), policymakers and transport authorities and other transport mode operators.

To achieve the study objectives and address the research gaps, the following three primary research questions were established.

1. How are UberX and Uberpool currently used in a city like London?
2. What attracts people to Uberpool in a city like London?
3. How do transport authorities and the conventional public transport industry deal with Uberpool in a city like London?

For this study, a mixed-methods approach involving the collection of quantitative and qualitative data was used. The quantitative data were collected using a survey of UberX and Uberpool users in London, which yielded 907 responses. The qualitative data were collected using a combination of interviews with 31 different transport policymakers, PT operators and other key stakeholders and focus groups with 28 London Uber drivers. The interview and focus group data were analysed using a thematic approach to find meaningful themes in the data. The survey data was initially analysed using descriptive statistical analysis and cross-tabulation. Moreover, several categorical regression (CATREG) models were developed for the survey data to investigate a greater understanding of the key factors that influenced how and why Uberpool services were used in London.

The results indicated that most Uberpool users in London were employed (77.4% of respondents) and educated to degree level (89.5%), with 60% of respondents using PT (i.e., Buses, Trains/Tube) for same or similar trips before Uber and 49.9% of trip purposes were going to "work, college/school, or PT station/stop". The key factors which influenced a passengers' decision to use Uberpool instead of PT modes included "perception on safety, compared to PT modes", "employment status", "age group", "trip purpose", and "car ownership at present". The results revealed that Uberpool was popular with students, travellers making social (i.e., night out) or long-distance trips. The findings highlight that transport authorities were currently poorly equipped (for various reasons) to deal with these new on-demand services, and there was a need to develop specific transport policy measures and regulations for ridesourcing services which considered input from all key stakeholders, including service providers, PT operators, the users, and ridesourcing drivers.

At the time of completion, this was the first study in the UK that used empirical data collected from key stakeholders (i.e., users, Uber drivers and policymakers) to investigate how shared (Uberpool) and non-shared (UberX) ridesourcing services are used and its relationship with traditional PT modes. The findings present important insights into the implications of ridesourcing services for traditional PT, active mode, and the influencing factors on why users adopt ridesourcing instead of other modes and the findings can support policymakers and transport authorities during policy and regulation development.

In this study, several key recommendations are offered, including the need to integrate ridesourcing services with other modes of transport in London (e.g., the PT) and providing guidance to ridesourcing and PT operators on how best these services should be integrated (e.g., payment systems) to complement one another and reduce negative impacts the city's PT network. Furthermore, suggestions on ridesourcing data collection and monitoring methods are presented to address the lack of ridesourcing data, which remains a significant issue in London. In addition, suggestions are made for developing specific regulations for ridesourcing, since there are currently no specific regulations covering ridesourcing in London, and these services are operating under the PHV regulations, which was not developed for these types of services and thus did not address the challenges brought forth by shared and non-shared ridesourcing services. The development of new ridesourcing regulations should involve consultations with all key stakeholders and should aim to maximise the opportunities offered by ridesourcing services whilst addressing the existing regulatory gaps in the taxi and PHV legislation, including driver standards, welfare (i.e., maximum working hours and sick pay) and defining clear responsibilities for all those who are involved in providing ridesourcing.

Considering this study's scope, several opportunities for future research are identified, including future research to understand inequalities in accessing and using ridesourcing services, particularly for the elderly and those who do not have access to the internet or smartphones. Moreover, additional studies are suggested to clarify the role of Uberpool services in fulfilling first and last-mile trips, including how often PT passengers used shared ridesourcing to connect to/from PT modes (i.e., the tube, trains, or buses). Further research is recommended to investigate the broader effects of all the different ridesourcing services on London's traffic congestion and the wider economic implications from these services, including benefits, disbenefits and the total costs of these services for the city, users, and the drivers.

Publications associated with this research

The following journal publications and conference proceedings have achieved during the research and are reported in this thesis:

Journal publications

1. Mohamed, M.J., Rye, T., Fonzone, A. (2019). Operational and policy implications of ridesourcing services: A case of Uber in London, UK. Case Studies on Transport Policy. 7:4, 823-836.
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Conference proceedings

1. Mohamed, M.J., Rye, T., Fonzone, A. (2018). The impact of shared ridesourcing services on public transport policy and operations. Presented at 50th Annual Universities' Transport Study Group Conference (UTSG), London, 3-5 January 2018.
2. Mohamed, M.J., Rye, T., Fonzone, A. (2019). The Utilisation and User Characteristics of Uber Services in London. Presented at 51st Annual Universities' Transport Study Group Conference (UTSG), Leeds, 8-10 June 2019.
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List of Abbreviations

ANPR	Automatic Number Plate Recognition
BRT	Bus Rail Transit
CATREG	Categorical Regression
COVID_19	Coronavirus Disease 2019
CPT	Confederation of Passenger Transport
DfT	Department for Transport
DLR	Docklands Light Rail
DRT	Demand Responsive Transport
EC	European Commission
EV	Electric Vehicle
FG	Focus Groups
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GLA	Greater London Authority
GMB	General, Municipal, Boilermakers' and Allied Trade Union
GPS	Global Positioning Systems
ICT	Information and Communication Technology
ITS	Intelligent Transport Systems
MaaS	Mobility as a Service
P2P	Peer-to-Peer
PHV	Private Hire Vehicle
PRT	Personal Rapid Transit
PT	Public Transport
RP	Revealed Preference
SAE	Society of Automotive Engineers
SP	Stated Preference
SPSS	Statistical Package for the Social Sciences
STAR	Short-Term Auto Rental
TfL	Transport for London
TNC	Transportation Network Companies
TOD	Transport Oriented Developments

TSU	Transport Studies Unit
UCL	University College London
UITP	International Association of Public Transport
UK	United Kingdom
USA	United States of America
VMT	Vehicle Miles Travelled
ZEV	Zero Emission Vehicle

Chapter 1: Introduction

People travelled primarily by walking, cycling, or using horses, trains, and boats before the 1900s. However, these modes were displaced, over time, or supplemented by newer transport modes (e.g., mopeds, scooters, bicycles, PT buses, trains, and personal cars). However, as urbanisation and travel demand increased in cities, traditional public transport modes, considering their limited capacity, have become increasingly overloaded during peak hours, thus creating increasing disruption, congestion, and emissions in cities. As a result, newer modes of transport such as ridesourcing, ridehailing and other on-demand shared services (e.g., shared micro-mobility) have started to take advantage of recent technological advancements such as mobile applications to offer on-demand alternative mobility options that negate the need to own a vehicle and streamline the process of booking, using, and paying for mobility services.

This chapter is divided into three core sub-sections that present the background and context to this study and establish the broad policy context of future mobility innovation including ridesourcing services. The first part of this chapter provides the primary definitions and concepts that are central to future mobility and indicates relevant theoretical perspectives for this study. In addition, the broad policy context and background, including mobility innovations, car use and ridesourcing services, are provided. The second part details the motivations and aims for this study and summarises the methods adopted. Lastly, the chapter concludes with an outline structure and brief summary for the remaining chapters of the thesis.

The next chapter will discuss the literature review for this study, including a broad review of the state-of-the-art in transport innovation, shared and smart mobility, Mobility as a Service, the sharing economy and transport and traditional for-hire services. In addition, a detailed review of the current literature on ridesourcing, including shared ridesourcing services, are provided, along with the research gaps that have been identified.

1.1 Background

1.1.1 Definitions

The definitions of key terminologies used in this thesis are presented.

- **Ridesourcing**

This term is defined as a,

> "Prearranged and on-demand transportation services for compensation in which drivers and passengers connect via digital applications. In addition, digital applications are typically used for booking, electronic payment, and ratings." (SAE International 2018).

The term "ride-hailing" is frequently used instead of ridesourcing in previous studies, particularly those conducted in North America. However, for consistency, the term ridesourcing is adopted in this study as per the (SAE International, 2018) definition.

- **Shared ridesourcing**

Shared ridesourcing refers to a type of ridesourcing service that can combine up to three separate trips going the same direction. This type of service is also referred to as pooled or taxi-sharing and is the cheapest form of ridesourcing service. An example of a shared ridesourcing service is Uberpool, offered by Uber in cities such as London.

- **Uberpool and UberX**

Uberpool is a shared ridesourcing service offered via the Uber ridesourcing app, which connects users to share an UberX vehicle by allowing users to share rides going similar routes, thereby reducing the per person trip cost. However, pickup and drop off location cannot be changed once an Uberpool trip has been requested (Uber 2016).

UberX refers to the standard (non-shared) Uber service that offers rides for up to 4 passengers on the same trip. It is the lowest cost non-shared service from Uber.

- **For-Hire Services**

This term is defined as services that,

> "… transport passengers for a fare (either predetermined by distance or time travelled, or dynamically priced based on a meter or similar technology).
> For-hire services include ridesourcing, taxi and limousines. The fundamental basis of for-hire services involves a passenger hiring a person operating an asset (e.g., a car)

for a ride. For-hire services can be prearranged through a reservation, or they can be booked on-demand through phone dispatch, street hail, or e-Hail using a website or smartphone app" (SAE International, 2018).

- **Ridesourcing service providers**

This term refers to companies (i.e., Uber and Lyft) that offer ridesourcing services using smartphone apps to enable people to secure shared and non-shared rides from drivers who use their own (or rented) vehicle. These companies are also referred to as Transportation Network Companies (TNCs) as defined by the California Public Utilities Commission (Alemi, et al., 2017).

- **Shared mobility**

There are various definitions of shared mobility; however, the following description is commonly adopted.

> "An intra-urban transport services in which multiple users access vehicles for a variety of trip purposes; this includes ridesharing, ridesourcing etc. along with traditional public transport and taxis services" (TCRP, 2016).

- **Ridesharing**

Ridesharing (also known as carpooling and vanpooling) refers to services that add additional passengers to a pre-existing trip, where the drivers are not for-hire, but they could be compensated for their time and mileage. This term is formally defined as,

> "The formal or informal sharing of rides between drivers and passengers with similar origin-destination pairings…" (SAE International, 2018).

- **Carsharing**

Carsharing (commonly known as car-club in the UK) refers to,

> "a service that offers members access to vehicles by joining an organisation that provides and maintains a fleet of cars and or light trucks. These vehicles may be located within neighbourhoods, public transport stations, employment centres or universities.
>
> The carsharing organisation typically provides insurance, gasoline, parking, and maintenance. Members who join a carsharing organisation typically pay a fee each time they use a vehicle…" (SAE International, 2018; Shared-use Mobility Centre, 2015).

Types of carsharing services include those that require customers to borrow and return vehicles at the same location. There is also the one-way or point-to-point carsharing model that allow customers to pick up a vehicle at one location and drop it off at another. On the other hand, peer-to-peer (P2P) carsharing allows car owners to monetise the spare capacity of their vehicles by enrolling them in carsharing programs.

- **Shared mobility**

Shared mobility includes public transport and various other services, such as bus shuttles, taxis, ridesharing (i.e., carpool) or car-clubs and is commonly defined as,

> “The shared use of a vehicle, motorcycle, scooter, bicycle, or other transport modes; it provides users with short-term access to a transport mode on an as-needed basis. Shared mobility includes various modes and service models that meet the diverse needs of users. It includes sequential sharing where different users share the same vehicle one after the other, or concurrent sharing, where multiple non-household users share the same vehicle for the same trip" (SAE International, 2018).

Additionally, it is also defined as,

> “An intra-urban transport service in which vehicles are accessed by multiple users for a variety of trip purposes; this includes ridesharing, ridesourcing etc. along with traditional public transport and taxis services” (TCRP, 2016).

- **Mobility as a Service (MaaS)**

There are several definitions of MaaS in previous literature, including two common descriptions as follows.

> “MaaS is a user-centric, intelligent mobility distribution model in which all mobility service providers’ offerings are aggregated by a sole mobility operator and supplied to users through a single digital platform” (Matyas & Kamargianni, 2017).
>
> “MaaS uses a digital interface to source and manage the provision of a transport related service(s) which meets the mobility requirements of a customer” (TSC, 2016).

- **Sharing Economy**

The concept of sharing economy is defined as,

> "An economic system in which assets or services are shared between private individuals, either free or for a fee, typically by means of the Internet" (Oxford Dictionaries, 2017).

Additionally, it is further defined by previous studies as,

> "An emerging economic-technological phenomenon that is fuelled by developments in information and communications technology, growing consumer awareness, proliferation of collaborative web communities as well as social commerce/sharing" (Botsman & Rogers, 2010; Kaplan & Haenlein, 2010).

- **Smart Urban Mobility**

This term is defined as,

> "Using technology to generate and share data, information and knowledge that influences decisions, enhance vehicles, infrastructure and services and deriving improvements for transport system operators and users and shareholders" (Lyons, 2018).

1.1.2 Theoretical Perspectives

Mode Choice Theories

Understanding the reasons travellers choose specific transport modes can support policymaking and transport operations so that the most sustainable modes can be promoted. Various theories are used to explain the motivations behind mode choice, including the rational choice theory, satisficing theory, and the theory of planned behaviour.

The rational choice theory makes three general assumptions. First, the theory assumes that preferences influence human behaviour and usually include goals or objectives rather than attitudes. In the context of transport, people select a particular mode of transport that is conducive to realising their goal, for example, reaching home quickly and safely using a cost-effective mode after a night out. Second, the theory assumes that factors that more or less limit the realisation of an individual's goals affect behaviour and third, people take advantage of their utility by choosing options that are best for them and those that provide the highest satisfaction (Opp, 2020) (Becker, 1976).

The third assumption implies that the selection of a particular mode of transport indicates satisfaction. In most studies on travel mode choice, which apply the rational choice theory, the key factors influencing behaviour include the availability of a car and the time and monetary costs involved (Davidov, 2003).

Rational choice theory often assumes that people always have all the information to make the best decision on the most appropriate mode of transport. However, this is not always the case. Herbert (1957) proposed an alternative decision-making approach – bounded rationality – which assumes that individuals are generally “satisficers” who experience satisfaction by making “good enough” rather than the best decisions. Herbert’s (1957) theory views “satisficing” as a more efficient decision-making strategy that is likely to be used in everyday decisions, including travel mode decisions. Satisficers reduce their effort and time by setting a criterion around their needs and preferences. They evaluate their possible options against the set criteria and pick the first option that meets the minimum level (Herbert, 1957) (Sivasubramaniyam et al., 2020). Travellers may develop criteria consisting of travel time, distance, cost, accessibility, and parking fees before making their satisficing travel choices (Avineri & Prashker, 2006) (Jou et al., 2010). For example, Di et al. (2017) noted that some people are only interested in using a new route if the length of travel time they can save is equal to the minimum length of time they are willing to travel. Also, habits play a central role in the satisficing decision-making strategy (Sivasubramaniyam et al., 2020). Habits entail decisions or behaviours carried out repeatedly to attain some goals. For example, Verplanken et al. (1997) found that habitual cyclists are less likely to search for information on alternative modes of travel before making travel choices for their daily commute. Hence, behaviours or decisions that are performed frequently are linked with high satisficing tendencies due to their low -effort and their habitual nature.

The theory of planned behaviour (TPB) is considered part of the theory of reasoned action (Ajzen & Fishbein, 1980); (Fishbein & Ajzen, 1975) (Ajzen, 1991). Central to TPB is a person's intention to choose a particular transport mode over others. Intentions may include the motivational factors that affect a person's behaviour and are hints of how much effort people are willing to exert to select an appropriate mode of transport (Ajzen, 1991). The theory gauges the intentions of individuals based on their strengths.

The stronger an individual's intentions are, the more likely they are to select one transport mode option over another. Behavioural intention can be expressed only if the behaviour in question is under volitional control. In Travel behaviour, two distinct factors determine travel behavioural control: personal living conditions and transport infrastructure. A traveller living in a big city with good access to public transport would score higher in perceived behavioural control compared to one living in a community with bad access to PT (Haustein & Hunecke, 2007).

Furthermore, most people consider their ability to use PT differently based on their experiences or expectations. For example, Si et al. (2020) confirm hypotheses related to the TPB model predicting a user's behavioural intention toward sustainable travel behaviour such as bike-sharing. TPB has been used to predict and explain various travel behaviours, including personal car use and public transport in the Netherlands (Aarts & Dijksterhuis, 2000) and the UK (Gardner & Abraham, 2010); and the introduction of bus passes in Canada (Health & Gifford, 2006). These studies extend the TPB to account for variance in intentions and behaviour when choosing a particular mode of transport.

Social Psychological Theories

Social psychology theories focus on helping people understand and explain social behaviours. These theories are mostly centred on particular social phenomena, including group behaviour, social influence, love, and prosocial behaviour, among many other aspects (Cherry, 2020). Social psychologists consider this theory a practical tool for highlighting what is known about a particular phenomenon (Sullivan, 2019). The main social psychological theories commonly used to explain travel behaviour, particularly sharing vehicles, include the theory of planned behaviour (Ajzen, 1991; Hall, 1966).

Zhang et al. (2018) proposed a structural equation model based on the TPB to help understand the key factors on vehicle sharing acceptance. The TPB can be used to understand travellers' sharing of vehicles since this act is considered a purchasing behaviour, where the intention is the most proximate determinant of behaviour. It exemplifies the willingness of a person to perform a certain activity such as travelling. According to TPB, people's acceptance of vehicle sharing could be influenced by three variables: attitude towards the behaviour, subjective norm, and perceived behavioural control. Accordingly, Zhang et al. (2018) put forward that these variables have a significant positive effect on the acceptance of vehicle sharing. Thus, this might be used to explain why some travellers adopt shared ridesourcing services.

Hall's (1966) proxemics theory may also explain the extent to which travellers share space with others when using PT modes. The theory argues that strangers are often forced into a close social distance in public transport, contributing to psychological or social discomfort (Hall, 1966). The level of discomfort intensifies with passenger density since this is likely to create much closer interpersonal space between the passengers (Merat et al., 2017). Other factors likely to contribute to such discomfort include lack of familiarity with others in the vehicle, as Bansal et al. (2016) noted, who reported that most respondents were comfortable sharing rides with a stranger for trips during daytime hours for short intervals. However, some travellers indicated that they find sharing rides with regular friends and family members easier. Merat et al. (2017) explain that sharing vehicles may be influenced by whether they are attended (i.e., with driver) or unattended (self-driving), and according to Hall's (1966) proxemics theory, the lack of a human operator in vehicles - in the case of self-driving vehicles - may increase the level of discomfort and lead to differences in mode choice, particularly for self-driving vehicles.

Economic Theories

Economic theories on transport generally deal with the allocation of resources within the transport sector, which is often achieved by applying regulations to limit or manage market entry and price (Joskow & Rose, 1989). Regulation of transport markets can be implemented through several ways, including the transport authority owning the assets and the means of production, which involves bringing the transport market into the public sector and does not have to function along free-market principles. Moreover, transport authorities could take direct intervention that might include setting out how service will be operating, usually on the premise of public interest (Cowie, 2010).

A type of economic regulation involves specifying the price to be charged using the theory of price. As an economic theory, the theory of price states that the price for any good or service relates to the link between supply and demand (Cheung, 1974). Transport authorities often set a maximum price that is below the equilibrium price to impact the market. Prices at the regulated fare sometimes create excess demand, and more people are likely to use a service than the market can supply (Cowie, 2010; Joskow

& Rose, 1989). This can be problematic and has often been controlled by paying the operator a subsidy. Apart from price, economic regulation may at times involve specifying the maximum increase in price allowed. In the UK, this is often fulfilled through an RPI-X% formula, where RPI concerns the prevailing rate of inflation and X to the value to which the increase in price is restricted (Mirrlees-Black, 2014; Toms, 2004). Additionally, transport authorities sometimes employ economic regulations that involve limiting market entry. For example, in many cities, taxi services are controlled in this manner, where the regulators set a limit on the number of licenses that can be issued (Cowie, 2010; Cairns & Liston-Heyes, 1996).

Whether transport modes such as ridesourcing are regulated largely depends on that jurisdiction's policy objectives. The primary objective of transport policy is to make the right decisions concerning the allocation of transport resources, including the management and regulation of transport activities (Rodrigue, 2020). According to UNESCAP (2020), there are three main reasons for regulating the transport sector. First, some transport modes are regulated to minimise the danger of monopoly exploitation. Second, regulation may be necessary where an unregulated market could contribute to the overlap of timetables, increased pressure to participate in dangerous practices and where there is perceived loss in the stability and reliability of transport services. Third, regulation may arise due to social objectives and the desire for the government to make transport modes provide subsidised services at a reduced cost. For example, the regulation of taxis and private hire vehicles in the UK stems from the principles of effective and fair competition (CMA, 2017). Finally, the transport regulators may also impose additional regulations in the transport market where, for instance, there are concerns surrounding traveller safety.

1.1.3 On-Demand Mobility and Car Use

Mobility is the movement of people, goods and services, and its importance is in the accessibility it provides, so contributing to people's lives and society in general. For example, transport provides access to jobs, education, communities, and healthcare and social services. Throughout the 20th Century, the reliance on the automobile grew, which continued to persist until the present day. However, people's travel behaviour is influenced by factors such as socio-demographics, location, costs, or available transport options (GOS, 2019). Lyons & Davidson (2016) suggest adopting flexible and open approaches to deal with uncertainty and address accessibility challenges using transport policy or investment and propose a triple access approach comprising "spatial proximity, physical mobility and digital connectivity" to support the decision-making process.

The use of road vehicles hardly existed before 1900 (Litman, 2020) However, a mere twenty years later (in the 1920s), traffic congestion was already a problem, and the first white road line was laid in London, UK (Lyons, 2015). During this time, personal car mass production was increasing, and car ownership was also becoming common. The price of the earliest mass-produced car, the Ford Model T, had dropped to $300 from its initial $850 (Litman, 2020). Vehicle owners faced the challenge of a lack of infrastructure to use, forcing further expansions on road infrastructure. As a result, cities were eventually decorated with parked cars and congested roads.

Since the 1820s, a wide range of passenger transport has been introduced, providing a significant impact not only on how people travel but also on how cities are organised and developed (Butkevičius, 2010). The advancement in technology has allowed people to travel farther and explore more areas, influencing when and how they travel. Mass public transport systems started in London and France during the 1800s, when omnibus, a horse-drawn car, was introduced, in which ten people could sit at a time (Rodrigue, 2020). After that, owing to the new inventions, the first cable car was tested in San Francisco in 1873 by Andrew Smith Hallidie (Sun et al., 2017). This invention's primary inspiration was to create a more secure transport mode on the city's hilly roads. As more innovations became available, transport continued to evolve, such as the introduction of the motorbus in the 1920s and bullet trains in the 1960s (Moovit, 2018).

Moreover, in the 1940s, the use of cycling grew with some governments providing official support, such as the UK, where the government constructed 280 miles of cycle lanes and cycling reached high utilisation. However, by the late 90s, the cycling trend reduced as the mass adoption of the personal car increased, resulting in sub-urbanisation and decentralisation of activities outside the cities (Saif et al, 2018). Also, the tram system introduction in the late 19th century is one of the successful transport innovations (Wilson et al, 2009). Moreover, other countries such as the USA and Brazil have implemented various public transport systems, such as Bus Rapid Transit (BRT), that provided a fast and convenient way to commute for the public (Wirasinghe, et al., 2013).

Lyons (2018), indicated that urban mobility has also been a long-term challenge for urban transport authorities that encounter limited capacity and investment, intensified by continuous demand from urban population growth. New business models of vehicle use, and ownership and the advancement of technology applied to mobility could help transform these problematic situations. The 21st century is considered the era of information technology, where technology has been embedded in every aspect of life leading to the digital revolution. The outdated methods of accessing goods and mobility services have been replaced with new and fast methods to make people's daily lives easy (Cascio & Montealegre, 2016).

Urbanisation and population densities have been increasing globally along with a rise in car use; hence, cities are facing transport-related challenges. Furthermore, new technology-driven, on-demand mobility business models that provide low-cost alternative transport to car ownership and public transport are affecting the way urban mobility services are provided and used in cities around the world. For instance, in 2014, Taxi and Private Hire Vehicles (PHVs) accounted for only 1.3% of total daily trips in London and in 2016, that grew to 1.4% (GLA, 2016), whereas over 12.1% of trips at night were being made using a taxi or PHV (TfL, 2017), these figures include ridesourcing services as there is no separate ridesourcing usage data in London.

The adoption of ridesourcing services has been increasing in recent years; however, it is not well-known how much of the recent changes in people's travel habits can be attributed to ridesourcing or other tech-driven habits such as the use of smartphone applications for online shopping, uptake of teleworking or the use of shared mobility services.

One of the objectives of transport authorities has been to minimise the need to travel. There needs to be a debate on how the transition to smart mobility might be governed so that its benefits to society and the environment can be realised and negative impacts reduced. This is difficult when there is no real-world quantification of the effects of new mobility services (Docherty, 2018). Li, et al. (2019) argue that implementing an effective mobility system that includes digital platforms for passenger transport can enhance cities' environmental and economic performance.

Recent innovations in the transport sector such as Mobility as a Service (MaaS) that use advanced ICTs have emerged and are providing fundamental challenges to urban transport authorities. This includes uncertainty about where technological developments and their impacts are heading and how to deal with and assign liabilities between the various stakeholders, including consumers, service providers, and authorities in this uncertain context (Pangbourne, et al., 2018). According to (Matyas & Kamargianni, 2017), all stakeholders in the transport sector stand to benefit from MaaS while passengers get flexible, cheaper, and reliable travel. Society benefits from travellers' responsible behaviour; transport operators increase revenues from a highly viable business model and governments achieves their efficiency and sustainable mobility goals.

Transport innovations have played a key part in transforming how people travelled in the past and are expected to do so in the future as there are possibly more new transport technologies and services being developed and deployed compared to the past. First, however, it is important to understand their effects (Litman, 2020). Furthermore, shared mobility services, including ridesharing and earlier types of ridesourcing services, indicate the potential to change the way people travel, particularly when linked with public transport or other shared modes (Martin & Shaheen, 2011; Chan & Shaheen, 2012). The shared mobility model has been driven by the concept of sharing economy, which has become a growing industry. The biggest companies offering new shared mobility services worldwide, such as ridesourcing, include Uber, Lyft, Grab and Didi Chuxing (Shaheen, 2020; Huynh, et al., 2020).

1.1.4 Ridesourcing Services

Ridesourcing (also commonly referred to as ride-hailing) is a new type of shared mobility that provides services using smartphone applications that rely on advanced ICTs to enable and organise for-hire services in real-time (Chan & Shaheen, 2012). Shared (also called pooled) ridesourcing services allow several trips going in a similar direction to be combined and offer cheaper fare while the trip fare is known in advance.

It has the potential to increase vehicle occupancy, therefore, decreasing single occupancy car trips whilst still offering convenience for users (Lavieri & Bhat, 2019).

Ridesourcing is an emerging business model that is providing an alternative to car ownership and traditional taxis services. Ridesourcing platforms allow individuals to use their car to transport others for a fee. Customers use a smartphone application to request a ride and to track the location of the requested vehicle. After the ride, payment is processed automatically via the app, and the customer rates the quality of service provided by the driver and the driver rates the passenger.

The largest ridesourcing company to date is Uber, which operates in 86 countries and over 10,000 cities globally (Uber, 2021). Lyft is another major ridesourcing operator mainly in the USA, whilst other leading operators with similar business models include Didi Chuxing in China, Ola in India, and Grab in South Asia.

Ridesourcing is described as one of the most ubiquitous forms of shared mobility (TCRP, 2016). It is part of the broader sharing economy that allows travellers to think about alternative ways to access and benefit from various services in different sectors, such as the transport and hotel industries, where new companies such as Uber and Airbnb have arisen. In this context, new types of on-demand shared mobility services (e.g., Uberpool) are becoming popular in cities like London, San Francisco, and Paris (Mohamed, et al., 2019). However, some described these services as "access economy" or "access-based consumption" and not necessarily sharing, because sharing involves non-market mediated access (Eckhardt and Bardhi, 2016).

The advent of new technology-enabled mobility services such as ridesourcing are transforming transport demand and supply in cities. These new on-demand mobility business models are disrupting the way urban mobility services are provided and used by offering low-cost alternatives to traditional modes of transport such as personal car ownership/use, taxi, and minicab services.

Ridesourcing services are some of the most rapidly growing forms of shared-mobility services in cities such as London, where the adoption of ridesourcing has multiplied since Uber services were launched. For example, Uber reported over 3.5 million registered users of its services in London, clearly a user base large enough to disrupt traditional travel habits in the city. In addition, the number of private hire vehicles (including Uber) in London has increased by 92% since 2008/09 to over 94,000 in 2019/2020; whilst the number of licensed PHV drivers has increased by 100% over the same period (TfL, 2020c).

Several types of ridesourcing services are offered via the Uber app, including the UberX service, which is the standard (low cost) option for single trips using a four-passenger vehicle (i.e., Toyota Prius). Uber also offers a shared service that allows different customers - with a maximum of two passengers per pick up - that are going in the same/similar direction to share rides, and as a result, each customer pays a reduced fare compared to the other Uber options, even if no other rider joins the trip.

The UberX service is most commonly available in most cities, while Uberpool services are available in a much more limited range of cities such as London, San Francisco, Paris, Singapore, and smaller cities including Austin (USA) and Graz (Austria). Accordingly, Uber services in London offer an excellent opportunity to obtain valuable empirical data on ridesourcing and understand how shared and non-shared ridesourcing services are used, by who and for what trip purpose and the potential consequences for traditional public transport modes in a UK city context.

The emergence of ridesourcing services has disrupted traditional PT and taxi services and thus initiated discussions among policymakers, transport authorities, and PT operators about the effects of these new services on traditional PT modes and the city's transport network. Moreover, due to a lack of data about how the services are used, the effects of ridesourcing services on traditional PT modes are not fully known.

1.2 Motivation, Aims and Methods

1.2.1 Motivation

In London, the Mayor’s transport strategy (GLA, 2018) sets out to achieve an ambitious public transport and active mode share of 80% and at least 20mins of daily active travel (per person) by the year 2041. The strategy contains 26 different policy measures and 108 proposals to achieve these targets. The strategy has several focus areas in delivering ‘healthy streets’ and a good ‘transport mix’, including reducing total traffic congestion (10-15% by 2041); 100% zero-emission taxi and private hire vehicles (includes ridesourcing) by 2033; 100% zero-emission public buses by 2050; and eliminating all road deaths and serious injuries by 2041. The strategy acknowledges the importance of flexible mobility options and the potential of on-demand services (as long as it does not adversely affect active travel) and the need to manage new mobility services. Furthermore, it provides specific policy measures for delivering coordinated public transport services that offer “an attractive whole journey experience” to help mode shift away from personal car use, whilst recognising the importance of supporting London’s ‘night-time economy’ which is said to be worth 8% of the city’s GDP and employs over 700,000 people. However, the strategy fails to directly address ridesourcing services in terms of operations, regulations, and policy implications (other than to seek more powers from central government to control the number of private hire vehicles) and thus, it is not clear where policymakers see ridesourcing playing a role in achieving (or hindering) the 2041 targets for London.

The rapid growth of ridesourcing services such as Uber in the last decade has disrupted traditional public transport and taxi services and thus created transport policy and operational challenges for transport authorities and policymakers. Moreover, there are discussions on whether ridesourcing services are just another type of taxi service or part of a different for-hire business model category. Previous research indicates that ridesourcing services are generally asset-light, peer-to-peer model of using personally owned cars to offer mobility services Shaheen (2018). However, ridesourcing companies (also known as Transportation Network Companies) argue that they are not transport service companies but rather software companies that develop software that facilitates on-demand mobility (Sfenrianto, et al, 2019) and often finds ways to evade traditional taxi regulations (Edelman & Geradin, 2016; Agyemang, 2019).

Research on ridesourcing services is growing, for example (Martin & Shaheen, 2011; Clewlow & Mishra, 2017; Chen, 2015; Zhao & Dawes, 2016; Hall, et al, 2018; Alemi, et al, 2019; Kong, et al, 2020; Young, et al, 2020). The literature review revealed that ridesourcing is part of growing shared mobility that has brought new challenges and debates by policymakers, users, and operators. Nevertheless, until recently, shared ridesourcing such as Uberpool has been under-researched, primarily because of limited data available on essential elements such as its impacts, usage characteristics and the rapid pace of development. Moreover, the implications of shared ridesourcing on other modes, including traditional taxi and PT, are less understood, and research on related policies and regulations are limited.

Uber has been operational in London since 2012, and the shared (Uberpool) services were launched in 2014. Traditional PT modes play an important role in London, and the city's mobility system is generally well advanced with many options. However, no previous data collection or empirical studies were conducted in London or the UK on these new services. Therefore, there is limited understanding of how ridesourcing services are used, why users adopt these services and the effects on public transport modes and congestion. Also, there was little evidence about any synergy between policymakers and the ridesourcing service providers. Hence, as more ridesourcing services emerge, policymakers and transport regulators in London need to address the operational, regulatory challenges from ridesourcing.

The literature review on the topic is presented in chapter two of this thesis and it revealed several key gaps, including that most of the existing research about ridesourcing was focused on a North American context, such as the USA. As a result, the findings do not generally address the UK or European specific policy and operational issues. In addition, shared ridesourcing services such as Uberpool are not sufficiently addressed in existing literature, including its effect and relationship with PT modes. Service providers commonly market shared ridesourcing as a beneficial option for users and the cities because of the sharing nature; however, there is no consensus on how or whether these services should be managed or regulated. Existing studies also do not fully consider the perspectives of all key stakeholders and often rely on one data source or viewpoint.

To address the research gaps and therefore contribute to the state-of-the-art on this topic, this study investigates the use of shared ridesourcing services and its relationship with public transport, using Uber services in London as a case study to understand the primary relationships between the service usage, reasons why travellers choose ridesourcing and the consequences for traditional PT modes and policymaking.

It is important to understand ridesourcing usage characteristics and the possible consequences of these services on traditional PT modes. Therefore, obtaining valuable empirical data on ridesourcing is essential while also considering key stakeholders' insights and viewpoints so that policymakers and transport authorities can develop suitable policy measures and regulations for these new services.

At the time of undertaking this research, this was the first research undertaken in London and in the UK that investigated ridesourcing services and their implication on public transport modes using three primary sets of empirical data to inform and provide support for transport policymaking in London.

1.2.2 Research Aims

This research aims to develop an understanding of ridesourcing services usage characteristics and how these new services work with public transport modes, using empirical data. In addition, to exploring the implications of Uberpool services on traditional public transport policy and operations.

1.2.3 Research Questions

The following research questions were developed to achieve the research aims and help fill the identified research gaps.

1. How are UberX and Uberpool currently used in a city like London?
2. What attracts people to Uberpool in a city like London?
3. How do transport authorities and the conventional public transport industry deal with Uberpool in a city like London?

1.2.4 Research Methodology

This study used a mixed-methods approach, comprising quantitative and qualitative data, to help answer the research questions. The quantitative data were collected using surveys of Uberpool and UberX users in Greater London. In addition, the qualitative data were collected using a combination of interviews with representatives from transport policymakers, transport authorities, regulators, PT operators, industry experts/innovators, researchers and ridesourcing service providers. Additionally, focus group sessions were conducted with London Uber drivers. The qualitative data were analysed using a thematic approach, while the quantitative data was analysed using descriptive statistical analysis and modelling.

1.3 Structure of the Thesis

This thesis comprises eight chapters. The structure and description of the remaining chapters of the thesis are presented below:

Chapter 2 presents the literature review, starting with the broader topic of transport innovation, shared and smart mobility, Mobility as a Service, the sharing economy and transport and traditional for-hire services. The review then provides a more focused and critical review of the current state-of-the-art on ridesourcing services, emphasising the shared ridesourcing, and hence several research gaps are identified in the existing knowledge.

Chapter 3 details the research methodology adopted for collecting and analysing data for this study. It explains the processes that were applied for each approach. In addition, details about the data collection and analysis approach generally used in transport studies are discussed, and the rationale and suitability of the methods used are provided.

Chapter 4 discusses London's public transport policy and operations and provides the reasons why London and Uber were selected as a suitable case study.

Chapter 5 presents the interview results. The interviews were held with 31 participants representing transport policymakers, transport authorities, PT operators, industry experts/innovators, researchers and ridesourcing service providers. Also, the findings are discussed, considering the research questions.

Chapter 6 presents the focus group results. The focus groups were held with 28 London Uber drivers. The findings are discussed considering the results of the interviews and the research questions.

Chapter 7 presents the Uberpool and UberX user survey results, including descriptive statistical analysis and categorical regression modelling. In addition, the findings relating to essential aspects of Uberpool that were important to the research are discussed.

Chapter 8 provides the conclusions and recommendations of this study. A summary of the study findings and details of how the research questions were answered are presented. In addition, a summary of the research implications and contributions is discussed. Finally, the research limitations and areas for further research are highlighted.

Chapter 2: Literature review

2.1 Introduction

Ridesourcing services are part of a fast-growing form of new mobility services, and this research investigates the use of shared ridesourcing services such as Uberpool and its relationship with public transport. Previous relevant studies are found on the broader topic of shared mobility, smart mobility, transport innovation and governance. Moreover, a significant amount of recent literature is found (albeit mainly in a North American context) on ridesourcing services, its impacts (including congestion and other modes), how it is used and by whom.

This chapter is divided into four main sub-sections that present a detailed review of relevant literature about the broader topic to set the context for the study and then provides a detailed review of the current state-of-the-art on ridesourcing services.

The initial part of this chapter looks at innovations in the transport sector and how this has shaped the current state of transport policy, operations, and services. An overview is provided of how urban passenger transport has evolved over the years. Moreover, a broad review of current research relating to various aspects of shared mobility is provided, such as ridehailing, carsharing, and mobility as a service. Furthermore, a literature review of for-hire transport and the effects of COVID-19 on urban transport is presented.

Next, a detailed literature review of the role of transport in the sharing economy and the usages and impacts of ridesourcing services is provided. Moreover, the policy implications from shared and non-shared ridesourcing services are discussed.

This chapter concludes with a summary of the research gaps that were found, the main research questions that were developed, and a brief chapter summary.

2.2 Transport Innovation

Introduction

This sub-section presents a review of relevant literature on innovations in the transport sector and how it has shaped the current transport policy, operations, and services. Besides, it provides an overview of how urban passenger transport has evolved over the years and offers a comprehensive review of research relating to different aspects of shared mobility, including ridehailing, demand-responsive transport, carsharing, smart mobility and mobility as a service. Furthermore, a review of for-hire transport and the effects of COVID-19 on urban transport are discussed.

Innovations in the Transport Sector

Car transport has had an upward growth trajectory facilitated by a mass vehicle ownership trend that began decades ago (Webb, 2019). The face of mobility continues to evolve, driven by emerging innovations. Innovation is a term denoting new and unique ideas that redefine the way things are done in a system (Sfenrianto, et al., 2019; Stromberg, et al., 2016). Smith et al., (2018) explain it as "a contingent process done intentionally to find creative ideas that go beyond conventional wisdom which is being used in a certain environment". Transport innovations are happening in the road transport, railway, and airline industries and these innovations, besides simplifying personal mobility, also target to achieve positive impacts on some modern problems like pollution, congestion, energy consumption, and quality of life (Alonso-Mora, et al., 2017; Borroni-Bird, 2012). For example, Uberpool is a shared ridesourcing service (also known as pooling) where commuters on the same route or destination are matched to share a car (Shaheen, 2020). The systems that facilitate the merging of multiple trips into a single ride have the potential to ease congestion and cut greenhouse emissions because there would be fewer vehicles on the roads (Shaheen, 2020). The European Union categorises modern mobility innovations into four areas: automation, connectivity, de-carbonisation, and sharing. Automation facilitates the performance of dynamic driving tasks, autonomously and connectivity enables vehicles to communicate with roads infrastructure and other road users using cooperative Intelligent Transport Systems (ITS). Moreover, these innovations allow passengers to access mobility on an "as-needed" basis (European Union, 2019). Furthermore, Sperling (2018), classifies state-of-the-art transport innovations into three main categories: electrification, automation, and sharing.

Research shows that an efficient mobility sector is considered an asset in global cities, as it supports economic development and facilities the efficient movement of goods and services without adverse environmental and societal impacts. In the past few decades, tremendous changes have been observed in the mobility sector, owing to continuous technological advancements (Giannopoulos, 2004). Initially, technological innovation was more concerned about improving vehicles' technical performance, mainly for road transport. At the end of the 1980s, environmental activists became active, promoting the significance of the mobility sector environmental footprint (Schade, 2016). Such growing pressure on a conventional transport system has been one of the motivating factors for introducing innovation and technological developments in the mobility sector. However, there are concerns about political, institutional, and economic challenges to implementing advanced innovations in the mobility sector (Priemus & Geerlings, 2010).

The recent disruptions caused by digital technology in many industries is evident, including in the mobility sector (Goodall & Dixon, 2015; Smith, et al., 2017; Davis, 2018; Watanabe, et al., 2016). These range from instant ticketing to connected and automated vehicles; thus, innovations are more tuned to providing convenience and efficiency in mobility. According to Harding, et al, (2016), this is mainly down to an exponentially high number of people owning handheld devices like smartphones. Innovations usually have some impact on demand and supply economics (Mahto, et al., 2017). For example, digitization has flourished in the sharing economy ecosystem, where goods and services can be procured or transferred anywhere and at any time (Ranchordas, 2017). When modern smartphones (such the iPhone) were introduced, it marked the onset of the mobility-on-demand systems that mobility service providers like Lyft and Uber would use to meet the mobility industry’s demands via mobile applications (Alonso-Mora, et al., 2017; Sperling, 2018). Mobility-on-demand, as an innovation, allows commuters to travel using single or shared mobility packages. It encompasses a variety of mobility solutions like bike-sharing, micro-transit, carsharing, ridesharing, shuttle services, and ridesourcing services (Shaheen & Cohen, 2018). Through a user interface, commuters get real-time information, plan, book, pay and customize travel requirements based on personal preferences. Smith et al. (2018) names this system where passengers’ travel needs are met by transport network companies (TNCs) via a digital application, a ‘Mobility as a Service (MaaS)’. It is an innovation that revolutionises the mobility sector by offering user-centric services via a digital application platform (Ho, et al., 2020).

Kamargianni, et al (2016) recognize, that one of the first MaaS concepts was initially proposed by Heikkila in Helsinki, which saw one of the first trials of MaaS in Finland in 2014. It was designed to cater to door-to-door and on-demand mobility services for Finnish commuters through an ICT enabled integrated platform and stands out as the system with the highest integration score (Kamargianni, et al., 2016). "Go: Smart" project is another commonly mentioned field operational test example examining the practicality of MaaS innovation in real urban contexts (Smith, et al., 2018; Sochor, et al., 2015). Having unified all mobility solutions in Sweden, UbiGo provided a simple web-interface where customers would seamlessly access various mobility options using smartphones. Concerns like reducing carbon emissions, noise, and congestion in urban travel are among the challenges that MaaS projects aimed to address (Sochor, et al., 2015). MaaS platforms have significantly increased over the past decade (European Union, 2019). Another form of on-demand service is Demand Responsive Transport (DRT) (Mageean & Nelson, 2003). Brake, et al (2007), explains that DRT services are sub-sets of flexible transport service, which existed before present-day ridesourcing. It is flexible in aspects such as route, passenger category, vehicle allocation and payments. Moreover, it has been in use for nearly 40 years in the form of ridesharing, shared traditional taxis and route-based shuttles and offered customers the option to dial-in services, book, and avail the service (Brake, et al., 2007).

More innovations are anticipated in the mobility sector during the next decades, thereby enhancing or replacing current options. As noted from current literature, the two factors most emphasized in emerging mobility innovations are end-user experience and sustainability factors. Borroni-Bird (2012) argues that cars are expected to be smaller, powered by electricity, and increasingly more connected so that congestion and air pollution problems are mitigated while offering the users utmost convenience. UITP (2016), recommends that mobility efficiency can be significantly improved and mobility challenges in cities addressed if shared mobility and autonomous vehicle innovations are merged. Between the year 2020 and 2030, ridesourcing is expected to be linked with autonomous vehicles (AVs) to provide users with shared driverless mobility accessed seamlessly through smart applications (QIC, 2016). As such, new technology will undoubtedly play a significant role in determining the direction innovation in the mobility sector will take.

2.2.1 Urban Passenger Transport

In ancient times, walking was the primary mode of transport, however this changed over Centuries with the advent of the motor vehicle and new technologies and services for passenger transport (Litman, 2020). Accordingly, road passenger transport has evolved over the past century along with the number of options available to travellers, especially in urban areas. Road-based passenger transport broadly refers to land transport options such as car-based transport, buses, and bicycle transport (EC, 2020; OECD, 2020). Although public transport remains the dominant transport mode, in recent times, cities have witnessed the introduction of new mobility services such as ridesourcing and bike and scooter-sharing services.

Lyons (2015), explains that car use levels per capita are found to be lower in dense urban areas than rural areas, while Headicar (2013), indicates the increase in urban living in the last decades has contributed to overall less car use per capita of population. Le Vine & Jones (2012), reported that over ten years, "car mileage per resident per year in London" decreased by 20% while it increased by 6% for rural residents, further indicating the car use is generally lower in cities.

Transport innovations have played a key part in transforming how people travelled in the past and is expected to do so in the future as there are possibly more new transport technologies and services being developed and deployed compared to the past. However, it is important to understand their impacts (Litman, 2020).

The development of ICTs and smartphones' introduction has revolutionized how people access everyday services, including mobility. Technology has enabled resources and tools, putting important information in the hands of users. As early as the 1960s, experts were already studying the adverse challenges that transport was bringing into cities (Lyons, 2015). Taxis had become a phenomenon and regulations were being passed in local cities regarding their safety, access to customers, and reduced congestion (Cetin & Deakin, 2019). Switzerland introduced the first carsharing service in the late 1980s (Heilig, et al., 2018). A decade later in the 1990s, shared mobility business models were adopted in Germany and eventually in the USA (Heilig, et al., 2018; Clewlow & Mishra, 2016; Bardhi & Eckhardt, 2012). Zipcar was among the earliest companies providing carsharing services in the USA, where it allowed its registered members to access vehicles on an "as-needed basis" and drive the cars by themselves. Over the next years, the carsharing concept underwent several transformations facilitated by car rental companies, where newer and improved carsharing services allowed commuters to pick-up a car and drop it off at another location at their destination, thereby introducing the free-floating and one-way carsharing business models (Clewlow & Mishra, 2016). Transport is also passing through a transformation phase, as it is now becoming more tailored as per the users' requirements and needs by keeping in view the increased consumption choices and convenience. Therefore, many digital platforms are introduced that allow people to book the vehicle of their own choice, enter the destination, and make payment through cash or credit card (Cohen & Shaheen, 2018). Uber emerged as one of the first ridesourcing service providers with the aim to digitalize transport, which has seen major disruption in the mobility sector. Currently, Uber operates in more than 85 countries around the world, with over 80 million global customers (Button, 2020). In 2012, Lyft was launched in the USA market as another digital mobility service provider that competed directly with Uber in the USA. Prior to the introduction of ridesourcing, people relied on cash, a whistle, and a phone call to book a vehicle, now digital platforms have made available everything using a smartphone. In addition, these innovations in mobility sector have facilitated the introduction of new shared ridesourcing and carpooling services such as Sidecar, Carma carpooling, and Uberpool which provide shared ride options to travellers at a lower cost, saving fuel, and helping to reduce congestion and emissions (Zhou, 2020; Masoud, et al., 2017).

Many modern cities are battling with pollution challenges mainly contributed by road transport. Sperling (2018), explains that in 1900, nearly a quarter of the vehicles on the USA roads were electric vehicles (EVs). However, this trend disappeared and reappeared almost a century later. California State in the USA made the first attempts ever to enact a Zero Emission Vehicles (ZEV) policy in the 1990s but failed. Nissan was the first manufacturer to re-launch the electric vehicle (EV) into the market in 2010 and as other manufacturers picked on this trend, California State revisited the ZEV regulations, thereby putting pressure on manufacturers to achieve a 15% EV-sales threshold by 2025 (Sperling, 2018). At around the same time, GPS-enabled smartphones were infiltrating the markets enabling Uber to pioneer the USA's first ridesourcing services. Travellers were able to find a ride by matching with drivers nearby using their smartphones. This new model proved desirable because it was cheaper and offered more convenience while maintaining the taxi's traditional look (Sperling, 2018). Furthermore Cetin & Deakin (2019) point out that before Uber, similar ridesharing was tried in the 1990s when a few cities in the USA and Australia implemented ride-matching and sharing systems using telephones and computers, but the program failed because very few drivers signed up.

According to Wong, et al (2020), mobility has taken a new trajectory, optimised by technologies like the internet of things and big data analytics. It has become more of a service distributed seamlessly through digitized platforms and less of an asset that needs to be owned for travelling thanks to the mobility solutions provided by transport network companies (TNCs). Li, et al (2019), explains that in the past few years, digital platforms for passenger transport have gained greater attention, especially in urban areas, for improving the quality of life and sustainability and argues that the environmental and economic performance of cities can be enhanced by implementing an effective mobility system. Population growth, particularly in developing countries, has considerably induced the demand for mobility services and such countries have started regularising the ridesourcing services providers like Uber, by providing them operational guidelines (Zannat & Choudhry, 2019). To fully realise the potential of new shared mobility services, there is a balance to planning and policymaking for new disruptive and unconventional mobility services.

2.2.2 Shared mobility

The use of new, shared forms of mobility - from carsharing and bike-sharing to dynamic, IT-enabled shuttle services and carpooling apps - has increased exponentially over the years (Shared-use Mobility Centre, 2015). People around the world use private cars to travel to work. Most of these commuter trips are single-occupant vehicle trips. In the U.S.A, for example, single-occupant trips represent approximately 77% of all commuter trips (Polzin & Pisarski 2013); similar percentages are found in Europe (European Environment Agency (EEA), 2010). However, technology is transforming transport services and the ability to conveniently request, track, and pay for trips via smartphone applications is changing the way people get around and interact with our cities (Shared-use Mobility Centre, 2016). Shared mobility includes various types of shared modes such as carsharing, ridesharing (i.e., car and vanpooling), shared micro-mobility (i.e., bikes and scooters), ridesourcing and taxi services (SAE International, 2018). The term shared mobility includes various on-demand services, including shared ridesourcing (Gilibert & Ribas, 2020). Ridesourcing differs from taxi services because journeys are pre-arranged and not hailed the way it happens with the taxi (Schwieterman & Smith, 2018). It is a disruptive innovation that has received much attention in recent times (Davis, 2018). The term 'ride-hailing' is commonly used instead of ridesourcing in previous literature, particularly in North American focused research. However, to keep consistency, the term 'ridesourcing' is used throughout this thesis in line with the (SAE International, 2018) definition of ridesourcing.

Although, there have been more recent research publications looking at ridesourcing in general, the shared ridesourcing services component is still under-researched and there is particularly limited published literature on impacts of shared ridesourcing services.

Research undertaken in the USA by the shared mobility centre (TCRP, 2016) indicates that greater use of shared modes is associated with a greater likelihood to use public transport frequently and lower car ownership. This research also suggested that shared services generally complement public transport but compete on some routes at certain times of the day. However, it does not provide evidence of impacts on a city's wider transport network.

Since the advent of Uber, Lyft, Didi-Chuxing and the likes, policymakers and transport authorities have debated where such services fit in a city's mobility mix, if they are a long-term sustainable mobility option and how to best deal with them. In this context Lam & Head, (2012, p. 359), described sustainable urban mobility as being the "ease, convenience, affordability and accessibility of travelling to one's destination with minimal impact on the environment and others". Although shared ridesourcing has come to the mix of available urban mobility options in recent times, there remains the question, whether ridesourcing (or shared ridesourcing for that matter) – which provide on-demand mobility, that needs little or no investment from transport authorities – helps to solve, or just exacerbates a city's mobility problems.

An important challenge for policymakers and the transport industry is how these new urban mobility solutions such as ridesourcing are governed. Not only in terms of policy and actions of the local authorities (Dowling & Kent, 2015) but, in a broader sense (Bulkeley, et al., 2016), dealing with processes where problems are identified, and interventions formulated and implemented, that aim to achieve favourable outcomes and prevent unwanted ones (Dowling, 2018).

Earlier research such as Martin & Shaheen, 2011b; Chan & Shaheen, 2012; Clewlow & Mishra (2017), studied the wider topic of shared mobility including ridesharing and earlier types of ridesourcing services and indicate the potential of shared modes especially when they are linked with the use of public transport or other shared modes. The shared mobility model has been steered by the emergence of the 'sharing economy' and it has become an industry, generating billions of dollars a year in revenues (Huynh, et al., 2020). Uber, Lyft, Grab and Didi-Chuxing are some of the companies offering shared mobility services worldwide (Shaheen, 2020; Huynh, et al., 2020). One of the advantages of sharing mobility is that it can be used sequentially, where different travellers use the same service or vehicle one after another or concurrently allowing different travellers to be bundled together on the same trip and taken to their end destinations (SAE International, 2018).

Another form of shared mobility that has seen a growth in popularity in recent years is shared micro-mobility, such as bike-sharing and shared electric scooters. Transport authorities deploy shared micro-mobility in cities to cater for short-trips and increase accessibility by integrating with primary PT services, thereby reducing car use and greenhouse gas emissions from the transport sector (OECD/ITF, 2020).

A recent study by Oeschger et al. (2020) highlights the importance of integrating micro-mobility with PT services. The study emphasises that micro-mobility and PT should be considered interconnected component of the transport system. Hence, planners, service providers and stakeholders should plan the required micro-mobility infrastructure (i.e., dedicated lanes) and facilities (i.e., storage and secure parking) in synergy with PT facilities and offer integrated payment methods to harness the potential of these modes fully. Moreover, incentives such as discounts for multi-modal trips or promotions for specific use cases should be considered.

Furthermore, according to research by Shaheen & Cohen (2019) micro-mobility has great potential, especially in urban areas and might account for 8 to 15 per cent of trips that are under 8km. Moreover, this is expected to grow significantly in the coming years because of the adoption of dock-less shared services. The dock-less micro-mobility options offer the most opportunities in terms of convenience; however, this concept provides the most challenges in terms of street clutter and footway management. Micro-mobility aims to bridge the first-and-last-mile gaps in the transport network and encourage multi-modal trips that connect users with primary PT services, places of interest and workplaces. Also, serving previously unmet travel demand and the need for convenient and affordable mobility options in urban areas.

Ridesharing

Ridesharing is another form of shared mobility that allows more passengers to be added to fill empty seats on a pre-planned trip and sometimes offered in real-time using applications. This is commonly referred to as carpooling in some parts of the world. Usually, the driver is not 'for hire' as it is in the case of ridesourcing and there is no direct payment mode to the driver. Travellers going to a similar destination join in one ride to save travel costs (SAE International, 2018; Shared-Use Mobility Center, 2015a). Vanpooling is a similar service except that the travellers share a bigger vehicle and pay their portion of the trip's cost. Other forms of shared mobility are on-demand micro-transit, and bicycle and scooter sharing. According to Sarriera et al. (2017), one characteristic of shared rides is that the commuters exchange time for money. For example, trips may take longer when travellers drop-off points are on different routes resulting in longer time, however this is compensated through lower trip cost (Sarriera, et al., 2017; Shaheen, 2020). Mireia, et al (2018), further indicate that cheaper trip costs were the main reason travellers in Barcelona often used shared services. Traditionally policy interventions that have succeeded in promoting ridesharing include implementing pricing parking, giving traveller benefits, and creating special travel lanes for high occupancy vehicles (Sarriera, et al., 2017). Shaheen (2020), investigated the impact of shared mobility and the potential, it holds for the future and proposed that as innovations seek to merge shared mobility with autonomous and electric vehicle technologies, a lot of trials are needed to test what works for shared mobility. Furthermore, this study suggests that public policies should make pooling services more attractive to users by giving shared vehicles priority and creating synergies with other sustainable modes.

Demand Responsive Transport (DRT)

One of the earlier forms of shared mobility is Demand Responsive Transport (DRT). Which provides an on-demand transport service that picks-up and drops-off passengers based on their needs (Mageean & Nelson, 2003), one type of DRT is commonly known as flexible micro-transit (or flexible transport), which are generally technology-enabled and offer flexible routing and flexible scheduling of services using minibus vehicles. These types of services fit in somewhere between taxi service and public transport bus (Mageean & Nelson, 2003; Weckström, et al., 2018), and aim to provide the closest to a door-to-door type mobility service, therefore providing a different alternative to car use (Sihvola, et al., 2012). DRTs are also used in some cases by transport operators to improve 'social inclusion' in areas where there are gaps that are difficult to cover by public transport (Brake, et al., 2007), but such services suffer many challenges including operational, institutional and economic hindrances (Jokinen, et al., 2019).

Empirical research on DRT in terms of operations or policy implications is found in current literature, for example, Brake, et al. (2007) undertook research looking at key lessons from flexible transport services and provides general guidance and some policy recommendations based on a study of DRT services in the UK and cities around the world. The emphasis was on adopting a "decision-making framework" to help identify how DRT services should be designed, operated, managed and key stakeholders, and suggests taking a more 'integrated approach' when providing such services. Furthermore, Jokinen et al. (2019), studied a particular DRT pilot (Kutsuplus) in Finland, looking at operational data and policymaking processes. The research cites 'high operational cost (one of the main reasons why service was stopped), longer-term fare and funding policy and enhancing decision-making processes' as key takeaways. Likewise, another study by Weckström et al. (2018) looked at the same case-study (Kutsuplus) from a user's perspective and found that users of the service were diverse with differing socioeconomic backgrounds and travel habits with the majority of trip purposes being social/recreational that were under 9km. Service integration (with other services), clear marketing awareness plan and user target groups identification were some of the main suggestions for that research.

Research by Mageean & Nelson (2003), investigated other DRT operations in Europe and found that it has the potential to serve 'low demand routes', which would typically be too expensive for regular scheduled public transport services. Although DRT still needs some level of subsidy (albeit less than conventional public transport) and the 'more regulated' the operating environment is, the less the conflict with traditional modes. Moreover, Mulley et al. (2012) used international case studies to study the main barriers encountered when implementing DRT, focusing on institutional (i.e., policy and regulations), operational and economic barriers. They concluded that the main challenges are legislative circumstances; DRT not having "mainstream public transport" status; lack of substantial service integration; and insufficient awareness of DRT amongst policymakers and public. Furthermore, Davison, et al. (2012) investigated potential markets for DRT services and found that the type of DRT implemented was not suitable for the market served in many cases. This is mainly due to lack of knowledge and stated that technology plays an essential role in responding to market demand in terms of service provision (i.e., booking, real-time information) and suggests merging the market via stakeholder collaboration and the re-evaluation of stakeholder roles.

Some lessons could be learnt from research on DRT services, such as those relating to service integration, stakeholder involvement and policy and legislative situations, however, it is not clear how transferable these findings and recommendations are to the present-day set up of ridesourcing services. This is because DRT is operated either by the public or NGO sectors, whereas with ridesourcing transport authorities and government entities, in general, have little or no involvement in its operations and service provision. it remains essentially a private sector organised service.

Carsharing

Another earlier form of shared mobility is Carsharing. Carsharing services are offered as station-based roundtrips, one-way trips, or free-floating. The station-based model allows users to rent a vehicle using mobile applications (or websites) and return it to the original pick-up point when finished. However, the one-way option allows the users to drop the car at a specific location usually aligned with their travel destination and free-floating, usually involves finding the nearest car on the application and leaving the car somewhere near the users' destination (Shared-Use Mobility Center, 2015a). Carsharing programs were introduced in Europe (Wagner & Sperling, 2000). In 1948, Zurich adopted the carsharing model, which later expanded to other European countries, such as the UK, Germany, Sweden, Netherlands, and France (Fleury, et al., 2017). Initially, such programs were based on collective ownership of a fleet of vehicles, mostly were non-profit, but after gaining popularity, some companies were established, which started to sell these services against a specific fee (Page, et al., 2017). In the USA, two carsharing programs, the Short-Term Auto Rental (STAR) in San Francisco and Mobility Enterprise by Purdue University started in the 1980s (Cohen & Shaheen, 2007). Afterwards, Australia and Asia have also adopted these models, especially in Malaysia, China, and Japan, owing to their growing economies and increased mobility needs (Jones, et al., 2017). Currently, carsharing systems are available in more than 30 countries, and it is also spreading to other parts of the world (Bocken, et al., 2020).

Research shows that access to carsharing significantly reduces the number of cars required in a city and incentivizes car sharers to limit their driving. A study of carsharing in North America by Brown (2015), found that each carsharing vehicle takes 9 to 13 cars off the road, since many people joining carsharing either sell their car or stop purchasing a car. The average car sharer reduces their annual driving by 43%, because of less driving and of switching from old, inefficient vehicles to newer, more efficient carsharing vehicles, for each household joining carsharing, greenhouse gas emissions are reduced by 0.84 tonnes per year per household according to (Brown, 2015).

Research conducted in the USA supports the notion that shared mobility services help reduce car ownership. A study by Lane (2005), found that 40% of all households joining carsharing schemes in Philadelphia, USA, owned one or more vehicles and these households exhibited a shift towards a carless lifestyle after joining the program. Moreover, a 2008 survey of more than 6281 carsharing members in North America found car ownership among the surveyed population dropped by approximately 50% due to carsharing participation (Martin & Shaheen, 2011a). Carsharing promotes alternative travel modes, such as public transit, biking, and walking (Shaheen, et al., 2012). Martin & Shaheen (2011a), further reported that the net change in all public transit was -1%; traditional public transit (rail and bus) was -3%; walking was +3%; and Cycling was +6%. These are all positive indications; however, what is not known is whether the same is true about the impact of shared ridesourcing services.

Further studies by (Berman et al. 2013), explain that carsharing has seen strong growth over the past decade and as of 2012, carsharing was operating in 27 countries, with an estimated 1.8 million members up from approximately 350,000 members in 2006, and (Zeng, 2013) indicated forecasted global membership to reach 12 million by 2020. Moreover, Duncan (2011) found that a third of San Francisco Bay Area households (800,000 households) have at least one vehicle with a usage pattern that is economically conducive to carsharing.

In the course of studying the adoption, usage and impacts of shared mobility, Clewlow & Mishra (2017) acknowledged that the majority of previous empirical research examining the possible impacts of shared mobility concentrated on carsharing. Mainly because carsharing was one of the earliest forms of shared mobility since it started in the late 1940s (Shaheen & Cohen, 2007), and in the UK in the 1970s (Cousins, 2000; Harms & Truffer, 1998; Shaheen & Cohen, 2013). A study by Cervero (2003) undertook a survey of carsharing members and non-members and reported on the socio-demographics of early users of the service and found primary adopters of the service were broadly the ‘young, moderate-income, non-traditional households without cars’, however, the study indicated that carsharing seemed to encourage travel. Other study by Cervero & Tsai (2004) that looked at the same carshare service showed that as carsharing services become more common, users were more likely to get rid of their car (12%) and most said they experienced a general decrease in vehicle miles travelled. Moreover, Martin & Shaheen (2010) found that joining a carsharing service helped to reduce average vehicles per household by 0.26 vehicles but observed that amongst carsharing service members, there was a small decrease in public transport use, although there was a larger increase in walking, cycling, and carpooling, and Firnkorn & Müller (2012) projected average vehicles per household reduction of 0.05 to 0.11. Furthermore, Stillwater et al. (2009) investigated the link between Carsharing and PT usage and concluded the linkages and impacts on one another is, to some extent, unclear.

Previous research shows some impacts by carsharing services on PT use and VMT. However, since Carsharing services were offered at busy, high-density locations, which usually benefit from having good PT access, so it is not clear whether the findings are a direct result of the introduction of carsharing services or if there were other influencing factors, such as, where users lived (location) or density, (Clewlow & Mishra, 2017).

The increased use of shared mobility has put pressure on policymakers and authorities to introduce new laws to regulate this emerging sector (US DOT, 2016). The existing literature has suggested that the introduction of various shared modes cannot solely solve the mobility challenges in megacities, owing to the growing urbanisation and car use (Monem & Ahmed, 2020; Zannat & Choudhry, 2019). Moreover, Luiu, et al. (2018) highlight the lack of inclusive research on suitable policies and shared mobility regulations. Shared mobility can play an essential part in broader mobility strategies that combine various shared mobility modes and conventional mass transport, but as the literature shows, this requires a joint approach that involves all interested parties.

Smart Mobility

The development of smart mobility services has drawn attention in recent times, especially in response to addressing challenges of growing urbanization and congestion with many new smart mobility initiatives and services emerging over the past decade, such as ridesourcing services and MaaS. Smart mobility largely relies on the use of smart technologies and developments in ICT and smartphone applications to provide one-stop-shop mobility solution, while supporting better management of the wider urban transport systems. Smart technology is a self-operative and corrective system that requires little or no human intervention with three important elements of "sensors, command & control and actuators" to provide basic capabilities of sensing, processing and decision-making, control, and communicating (Akhras, 2000). It takes more than one dimension and incorporates aspects like sustainability, connectivity, and autonomy under one umbrella (Moscholidou & Pangbourne, 2020). In addition, smart mobility uses digital networks to optimise infrastructure, services, and travel behaviour (Papa & Lauwers, 2015). Furthermore, Neckermann (2015) argues that smart mobility is a new vision with "zero emissions, zero accidents, zero ownership", while Viechnicki, et al. (2018) represents it as a revolutionary way of thinking about how to get around, be more efficient, safer, and cleaner.

The idea of making transport smarter is not new, for example, Garcia-Ortiz, et al. (1995) discussed how various cities have developed smarter transport systems by introducing smart technologies, while Debnath et al. (2011) explained, how Singapore has used the Singapore smart technology initiatives to make the transport smarter. The

Smart mobility initiatives take advantage of the current advances in ICT technologies, platform applications and the integration of Intelligent Transport Systems (ITS) in both V2V (vehicle-to-vehicle) and V2X (vehicle-to-everything) in order to facilitate the realization of city-wide smarter mobility that supports transport objectives such as reducing congestion and emissions. However, many factors influence smart mobility, which all play a role in how effective it is, and the important factors include accessibility, availability of ICT infrastructure and effective policymaking (Giffinger, et al., 2007). In the context of a smart urban transport, several researchers such as Goldman & Gorham (2006) and Santos et al. (2010) have identified the implementation of smart technologies as the central element in achieving smart mobility. Furthermore, Debnath et al, (2011) & Haque et al. (2013) showed smart technologies can support sustainable transport by achieving greater economic and environmental efficiency. Mobility is becoming on-demand, user-interface oriented and service driven, where technology such as ICTs and smartphones applications, play a key role in collecting data, providing information to users, and managing all planning, booking and payment solutions for mobility services such as Uber or Lyft. As such ridesourcing services rely on mobile technologies such as smartphone applications in terms of how the services are operated and used. Smart mobility systems enhance the transport network's abilities and place it in a new context that is highly interactive and connected.

The sudden evolution in intelligent mobility contributes to improved performance and allows new functionalities and services to be frequently introduced including information made available to mobility drivers, users, and operators.

Smart mobility emerges from the concept of “smart growth” characterised by principles that drive sustainable developments. Smart growth makes urban investment attractive and, most importantly, curbs the problems caused by urban transport like pollution and congestion (Shaheen & Meyer, 2017; Lyons, 2015). Lyons (2018) claims that smart urban mobility is one that achieves convenience, connectivity, and affordability in urban areas while minimizing the impact on the environment. In addition, Porru, et al. (2020) suggest that smart mobility is one of the best ways to alleviate increased traffic congestion and pollution in urban areas. Research by Moscholidou & Pangbourne (2020) suggests that to facilitate smart urban mobility, transport authorities should regulate the sector and make the smart mobility stakeholders accountable for the impacts they help create. For example, the Mayor of London, outlined in his 2018 transport strategy, new emission standards and best practices which smart mobility service providers should aim to meet.

Furthermore, the UK government published the urban strategy (Future of Mobility: Urban Strategy) in 2019, setting out its approach of working with local authorities, companies, innovators, and other stakeholders to get maximum benefits from new urban mobility solutions and innovations. It hopes to motivate the development and trialling of new smart mobility services and models and contributing to smart city goals (DfT (UK), 2019). Other research by Paulsson & Landgren (2020) and Orlowski & Romanowska (2019) also concludes that smart mobility should be linked with other smart city goals since more rewards can be gained by focusing on addressing traffic issues using smart mobility instead of building more roads and highways.

Papa & Lauwers (2015), state that smart mobility alone is not sufficient to achieve effective and smart urban mobility. Nevertheless, policymaking, and other factors such as human capital, education and space quality should be considered for smart mobility to be functional and beneficial (Lam & Head, 2012). Dowling (2018) concluded that governance should always be adaptable and flexible so that the challenges brought by smart mobility can find the space to thrive.

Similarly, Marsden & Reardon (2018) mentioned that smart innovations can succeed better if done in phases of continual trial and experimentation and in environments where the government and users have coordinated efforts. Goldman & Gorham (2006), group the main factors that should be considered when developing smart mobility policies: (i) new mobility - the factors that drive individual travel decisions; (ii) city logistics - how goods move in the urban context; (iii) Intelligent system management - how government and transport infrastructure relate; (iv) Liveability - how the society interacts with the transport system.

The effectiveness of a city's transport system has a significant impact on a city's attractiveness to prospective investors and employees. At the same time, the city's growth presents its leaders with significant challenges and opportunities. Research by IBM (2009) estimated that by 2050 the highest levels of VMT would be undertaken in the developing world. For example, developing cities in Africa, Latin America, Middle

East, and India with the dominant mode being the vehicle-based modes, whilst the OECD countries (e.g., European countries, North America) are predicted to see very little increase. This indicates that developing nations will play a key role in shaping the future of mobility in general and particularly smart mobility. However, these developing nations could learn from the developed nations and leapfrog to an integrated smart mobility position since most of them will be starting from a very low base. An example of this is the Gulf Countries in the Middle East, where cities such as Dubai, Abu Dhabi and Doha are implementing some of the most advanced mobility systems from highly adaptive and artificial intelligence-enabled traffic control systems to driverless tram systems and fully integrated ridesourcing and taxi services.

Mobility as a Service

Mobility as a Service (MaaS) connotates a variety of mobility services combined and integrated under one platform to create a seamless interaction between travellers and mobility providers (Wong, et al., 2020; Mulley, et al., 2018; Goodall, et al., 2017). Furthermore, MaaS allows commuters to conveniently access tailored mobility services through smartphones instead of buying or owning the means of transport (Kamargianni, et al., 2016; Sarasini, et al., 2017). MaaS providers offer one platform where all mobility services such as rail, bus, bike, scooter, car rental and sharing, taxi and ridesourcing are offered as elements within mobility package. The characteristics of MaaS that distinguish it as a seamless mobility service include ticket and payment integration, the mobility package, and ICT integration using a web interface or application (Kamargianni, et al., 2016; Matyas & Kamargianni, 2017; Hensher & Chinh, 2018).

MaaS aims to help solve modern mobility challenges (Smith, et al., 2017) and its success largely depends on the size of the transport network and the number of modes which are integrated into the MaaS platform (Molkenthin & Manik, 2020). Furthermore, Shaheen et al. (2016) identified four types of applications that help to achieve efficiency and reduce congestion in digitalized MaaS, which are mobility apps, vehicle-connectivity apps, smart-parking apps, and courier network services apps.

The digitization aspect of MaaS has brought about newer paradigms of mobility provided by companies like Uber, where commuters use handheld mobile devices to choose on-demand mobility (Hensher, 2016). It has also necessitated other services like ridesourcing and ridesharing (Wong, et al., 2020); As shared ridesourcing services such as Uberpool and Lyft Shared have given travellers cheaper options and overall help to reduce single-occupancy car travel and thus vehicle miles travelled (VMT) (Morris, et al., 2020). Consequently, MaaS has prompted positive feedback from users due to the convenience it offers in terms of affordability, flexibility, reliability, and real-time and on-demand mobility (Polydoropoulou, et al., 2018). Research by Kamargianni (2016) found that travellers perception of public and shared mobility became more positive as demand for the services grew after having experienced the use of MaaS. Moreover, Sarasini et al. (2017) suggested that effective MaaS business models need to focus on pricing strategy, customer segmentation, and the effects of the different modes on travel behaviour.

Other studies by Polydoropoulou, et al., 2018; Alyavina, et al., 2020; UITP, 2016 & Jittrapirom, et al. (2017) indicates that MaaS can aid in reducing dependence on and ownership of private cars thereby helping to reduce congestion and pollution in cities. Furthermore, research by Ho, et al. (2020) investigated the impact that MaaS has on travellers' dependence on cars and found that MaaS was more appealing to people who owned cars and at the same time used PT compared to people who only used PT. The study also found that the "pay-as-you-go" characteristic of MaaS increased its uptake.

According to Brake (2007), when introducing policies for MaaS, stakeholders, service providers and PT authorities should form partnerships to eliminate the challenges imposed by geographical boundaries, regulations, and system integration, which, if not handled well could lead to service issues and loss of flexibility. A good example of collaboration between governmental authorities and private sector service providers was in Helsinki, Finland (Brake, et al., 2007) and in Gothenburg, Sweden, (Smith, et al., 2018).

Matyas & Kamargianni (2017), argue that there is optimism around MaaS because the technology is in the initial "hype cycle" phase and therefore MaaS is still at the early stages development, and it is not clear if it will become the ultimate mobility solution that the transport sector needs.

2.2.3 For-hire Transport Services

For-hire transport includes traditional taxi and black-cab services, which have been common in cities like London and New York before the arrival of ridesourcing companies (also referred to as TNCs) such as Uber (Wang & Smart, 2020). Shaheen (2020) suggests that even the ridesourcing companies fall under the 'for-hire' services except that they have been enhanced using digital platforms. According to Wang & Smart (2020), the entry of ridesourcing services offered by Uber and other similar companies has negatively impacted the jobs and hourly wages of conventional for-hire limousine services and conventional taxi drivers. This study found that in New York city, medallion licenses held by taxi drivers have lost much face value, following the emergence of ridesourcing companies, which do not even provide professional training to drivers. The Medallion licensing system originally helped to maintain the supply of for-hire traditional taxi services at a sustainable range so that drivers could make reasonable income and the city has enough supply. However, the medallions system has not evolved and could not match the fare, flexibility and vehicle options offered by ridesourcing companies (Button, 2020).

The regulation of traditional taxi services dates back to late the 1920s after the great depression, which left many people unemployed. Amidst falling incomes, many unsafe vehicles flooded the transport service market offering cheap taxi service. The surplus supply in versus demand led to conflicts amongst drivers forcing authorities to intervene through regulation and eliminate the illegal cabs (Harding, et al., 2016). Although, regulations have always guarded traditional for-hire services, ridesourcing companies have been clashing with the regulators who are mostly concerned about the negative impacts that ridesourcing companies are having on traditional taxi services and city-wide traffic and mobility conditions (Morris, et al., 2020). For example, in 2012, New York City, suspended UberX's operations at its infancy following pressure from the taxi and limousine commission to halt Uber services (Button, 2020). Another example is London's case, where the transport authorities twice refused to renew the licence for Uber in London, and there was a lengthy court case involving Uber and Transport for London (Mohamed, et al., 2019). The taxi and ridesourcing companies have been in a conflicting position for several years, calling for strategic policies and new regulatory frameworks to deal with the present issues (UTG, 2017).

Rogers (2015), argues that Uber, as a new form of mobility improves the traditional taxi and therefore with enough political-will and necessary regulations could be viable options. However, a change in transport policy is needed to arrange the different services, which is not easy because it affects many stakeholders and interest groups including the government, who will need to keep up with the pace of change (Marsden & Docherty, 2013). A study by Ranchordas (2017), suggests that regulating the new services brought forth by the sharing economy has not succeeded, mainly because regulators pursue it from the traditional perspective instead of looking at it as a business model, which has morphed into something new. To harmonize interests of ridesourcing companies and taxi services, Schaller (2016) recommends that regulators should focus on how services are acquired under each mode instead of trying to look at how the two services differ, thereby reaching a common ground on creating policies that protect and benefiting the interests of all concerned including the drivers on both sides. Moreover, deregulation of the taxi industry is suggested by Motala (2016) as a solution to making the traditional for-hire services (i.e., taxi) more competitive against their new competitors. It will increase the supply of taxi services and reduce waiting times experienced by customers because similar outcomes have been witnessed in countries which have done this, such as Ireland and New Zealand.

According to Wang & Smart (2020), the entry of ridesourcing companies in the transport sector has brought positive benefits even for traditional taxi operators and concludes that Uber’s presence increased the chances of the traditional taxi drivers finding new employment by 29%. Moreover, Jin et al. (2019) also indicated that Uber had done more to improve transport accessibility in the low-income areas than the traditional taxi services.

The Effect of COVID-19 on Urban Transport

The empirical component of this research was completed before the COVID-19 global pandemic started; However, COVID-19 had a substantial effect on transport, including ridesourcing, from the beginning of 2020. Therefore, the emerging research findings on the effects of the pandemic on transport services are summarised.

The novel Coronavirus (COVID-19) pandemic was initially detected in December 2019 in Wuhan, China, and within weeks the virus was found in many countries in Asia, Europe, and the Americas (Jiang, et al., 2020; Lipistch, et al., 2020) and by March 2020 the world health organisation declared it a pandemic (WHO, 2020).

COVID-19 has disrupted all aspects of life across the world during 2020, and the mobility sector has been heavily affected. During the peak of the pandemic, the effects on mobility were more exacerbated by the lockdowns and limited movements imposed by authorities in cities where high rates of the virus were detected, such as London, New York City, and Paris. The worse hit was the aviation industry because of closed borders and airports and many airlines suspending services.

Urban transport was also severely affected by the COVID-19 restrictions and demand decrease as many people worked from home. For example, during the first peak of the pandemic, public transport in London was operating limited services and according to data from the UK Department of Transport, ridership on the London Tube was down an average of 94% in April and May 2020, while in the same period national rail use was down an average of 95% compared to the same period in 2019 (DfT, 2021). Moreover, New York City MTA reported in March 2020 a 60% fall in Subway ridership and 90% on commuter railways usage (NYT, 2020). Gao, et al (2020), stated a subway ridership decrease of 91% in NYC during April 2020 and a 79% decrease in PT demand in Seattle during March 2020 compared to the same period in the previous year. Furthermore, Uber reported suspending the Uberpool service in most cities that Uberpool operated to reduce the chance of spreading the virus. Uber also implemented other guidelines and restriction for the standard UberX services; these included not allowing passengers to use the front passenger seat and the compulsory use of masks, providing hand sanitisers and wipes and regular sanitising and cleaning of vehicles. Uber has also reported providing over 300,000 free rides and meals for national health service staff and launched Uber Medics, “a new service designed to allow drivers to opt in to support frontline staff during a time when non-essential travel is restricted” (Uber, 2020). One area of transport that has seen growth during the COVID-19 pandemic has been E-commerce logistics and micro-mobility (The National Academies of Sciences, 2020).

New studies investigating the impacts of COVID-19 on transport are emerging. For example, (De Vos, 2020), investigated the effect of COVID-19 related social distancing on travel behaviour and argues that travel demand will reduce, and people will travel less by public transport because of social distancing requirements and more people working from home and undertaking e-learning, thereby resulting in less congestion and reduced PT ridership. The study notes active travel as an important way to travel safely within short distances and maintain wellbeing and suggests that policymakers should encourage active travel by creating more dedicated routes in under-used road space, which was also indicated by King & Krizek, 2020; ITF, 2020 ; Ali et al. (2020).

Furthermore, Dzisi & Dei (2020), highlighted the importance of social distancing and face mask requirements when using PT and suggests that authorities should do more by providing free masks and undertaking more enforcement. Research by Abdullah et al. (2020) explored the impacts of COVID-19 on travel behaviour and mode choice using an online survey and found a significant divergence in trip purpose, distance travelled and mode choice before and during COVID-19. The primary trip purpose reported was going to/from shopping and more people shifted to using non-motorised and private transport modes, whilst PT and paratransit use decreased significantly. The nature of the advice given by governments during lockdown, and travellers wanting to avoid infection by opting for private modes of transport were cited as crucial factors. Moreover, Warren & Skillman (2020) showed a broad decline in transport use was primarily because of government advise on controlling the spread of COVID-19 and general fear from the virus.

Although specific research examining the impact of COVID-19 on ridesourcing services is limited, a study by (Loa, et al., 2020) explored COVID-19 impacted ridesourcing services in Toronto, Canada and acknowledges that initial studies indicate a strong preference for using private cars and active modes. In addition, to highlighting the potential of ridesourcing to help improve access to mobility for those without a private car or those who have concerns about using PT options. This study used a survey to collect data with categorised periods of pre, during and post-COVID-19 to understand the impacts of the pandemic. The study found that ridesourcing use for commuting and non-commuting trips during the pandemic was almost half compared to the pre-COVID-19 situation. Respondents cited the main reasons for this being health concerns, less need to travel and the aim to avoid shared spaces and surfaces. Besides, many respondents indicated they would not use shared ridesourcing post-COVID-19, primarily because users want to avoid sharing with strangers and there is a perceived risk associated sharing with other customers. The findings also suggest the pre-COVID-19 situation, may not be reached until the pandemic is entirely over and demand for travel reaches pre-COVID-19 levels (Loa, et al., 2020). Another study by (Otieno, et al., 2020) investigated the impacts of the COVID-19 lockdown on ridesourcing drivers in South Africa and Kenya. They found that as soon as lockdown started in March 2020 most ridesourcing drivers saw a significant decline in their income. Some drivers had to stop work and look for alternative ways of earning an income. Although they could continue operating ridesourcing service during the lockdown there was limited (or no) demand for the services and people were afraid or reluctant to use ridesourcing. Moreover, since drivers were classified as independent contractors by ridesourcing companies like Uber, the drivers could not access social protection benefits that are offered to regular employees. This created discontentment towards the ridesourcing companies and the authorities for lack of suitable gig economy labour regulations, especially considering drivers' risk of catching the virus from passengers.

Furthermore, Hu et al. (2020), investigated the mode shift caused by COVID-19 on road traffic using historical USA Census Bureau data and estimated travel demand and travel times, and suggested that if PT ridership does not return, travel times will increase therefore highlighting the importance of restarting PT use analogous to car use. Moreover, (Katrakazas, et al., 2020) studied the effect of COVID-19 on driving behaviour and safety using data from smartphone applications in Greece and the Kingdom of Saudi Arabia. The study found that traffic volumes reduced significantly during the lockdown, whilst driving speeds increased by 6 to 11%, in addition to increased rough acceleration and braking and mobile phone use and reported a reduction of 41% in road accidents during the first peak of March to April 2020.

Findings from recent studies recognise that COVID-19 is affecting mobility in the short and medium term, however, long-term effects are still unclear. Therefore, policymakers and operators need to understand shifts in underlying travel behaviours and thus develop measures that not only bring back PT ridership to pre-COVID-19 levels but also consider future outcomes and seize the opportunity to prioritise and promote sustainable mobility options such as micro-mobility and further develop work from home policies to reduce travel demand and employ innovation and technology to help address some of the key challenges (Shaheen & Wong, 2020; ENO, 2020). Moreover, Shabanpour et al. (2020); Hensher & Beck (2020), emphasise the potential of work from home policies may have on travel and mobility in general, in the long term, while noting the negative perceptions about productivity.

Further research is needed to fully understand the long-term consequences of the COVID-19 on urban transport, travel behaviour and the sharing economy.

2.3 Ridesourcing Services: Usage, and Impacts

Introduction

This sub-section presents a thorough review of the role of transport in the sharing economy model and discusses where ridesourcing services fit within that model. Furthermore, it provides details about the usage characteristics of ridesourcing services and the impacts on urban transport, such as traditional PT and taxi services. Moreover, the consequences of ridesourcing services on traffic congestion, pollution and road safety are discussed.

2.3.1 Transport in the Sharing Economy

The notion of the ‘Sharing Economy’ has been widely debated in recent years, in the transport sectors, and other sectors such as hospitality sector. In the mobility sector, the emergence of the sharing economy has opened new opportunities where personal car ownership and usage is changing, driven by the adoption of digital applications and environmental and economic pressures in cities (UITP, 2016b). The 'sharing economy' concept facilitates businesses and households to take advantage of advances in technology by renting out underutilised assets (Wallsten 2015). Moreover, this concept has streamlined the apportioning of physical and non-physical goods and services using different information systems on the Internet (Wallsten, 2015; Hamari, et al., 2016). It provides an opportunity for the transport sector to shift away from the conventional ownership model towards an access-based model (Brown, 2015).

Within the last decade, new mobility options have emerged, such as ridesourcing, providing broadly low-cost alternatives to car ownership. These services could save households money by avoiding the large upfront costs of car ownership or large monthly payments, but still moderately higher cost per trip than PT, so travellers can opt for PT, cycling, or walking when required. Furthermore, shared-ridesourcing has the potential to increase vehicle occupancy through pooling, leading to efficient use of vehicles by many people (Brown, 2015).

Ridesourcing plays a part in the sharing economy by turning vehicles that would otherwise sit idle into on-demand taxis (Wallsten, 2015; Lo & Morseman, 2018). Research by Wallsten (2015) and Fielbaum & Tirachini (2020) explains how this process works and highlights that, once a request is made, the fare is known before the trip starts and an agreed percentage of each fare goes to the ridesourcing company at the end of each trip, while the rest is deposited into the driver's account.

The advance of information technology (such as web 2.0) has aided the advancement of application platforms that support user-generated content, sharing, as well as collaboration (Hamari, et al., 2016; Wallsten, 2015). These advances are considered as diverse illustrations of the "sharing economy" phenomenon (Hamari, et al., 2016; Wallsten, 2015; Schwieterman & Smith, 2018). In the transport sector, the concept works by matching cars to consumers prepared to pay for the services. These services are not new considering that taxis existed and provided flexible modes of mobility for decades. However, the creativity of the sharing economy is in utilising the power of new technologies to allow new players to offer taxi type services, without owning any physical assets, all outside the industry setting. According to (Hamari, et al., 2016) some of the technologies that facilitate the "sharing economy" include smartphones, payment systems, GPS, identification, and mechanisms to provide feedback; this phenomena substantially reduces the cost of matching under-used cars to anyone willing to pay to use them. This new approach for offering taxi type services has grown in popularity, with a 2015 PricewaterhouseCoopers survey revealing that 19% of adults in the USA partook in a 'sharing economy' activity (PwC, 2015), the number is now potentially higher than this estimate.

New competition across various industries has arisen from the advancement of the sharing economy. In the transport industry, Uber and similar ridesourcing services seem to provide direct competition to traditional taxi and private hire vehicle industry, which have for a long time faced imperfect competition from public transport options (Lo &

Morseman, 2018). The rivalry posed by ridesourcing services emanates from the fact that they are increasingly convenient and provide an on-demand means of mobility, which is generally more efficient and quicker (Schwieterman & Smith, 2018). In other industries, similar situations are arising, for example in the hotel industry, instead of having homes or rooms sit empty much of the day, Airbnb makes it possible for owners to rent those spaces at a fee. Studies on the effects of Airbnb on the sharing economy model indicate that the increasing number of rentals listed on the platform relate to lower revenues and prices reported by traditional hotels (Wallsten, 2015).

The diversity of experiences, lower prices, and the handiness of most sharing economy services have contributed to increased regulatory uncertainty (Posen, 2015; Rogers, 2015; Li, et al., 2019; Tirachini, 2020). In recent times, regional and national regulators are making efforts to respond to the regulatory challenges. At the same time, the taxi industry has responded by demanding that ridesourcing services comply with the already-developed taxi and private hire regulations, especially those relating to entry controls and pricing (Posen, 2015; Nie, 2017). To counter this, digital platforms-based service providers and experts maintain that the sharing economy is different from traditional businesses and so should be considered differently (Posen, 2015). This has popularised the idea that regulators should count on trial policies for safety, allowing travellers to choose which service they would like to use. Even though innovative, the sharing economy contributes to some negative externalities (Posen, 2015; Rogers, 2015; Li, et al., 2019; Tirachini, 2020; Nie, 2017; Lyons & Davidson, 2016) that should be addressed to protect the interests of society.

Research by Conway (2018), analysed taxi and ridesourcing data from 1995 – 2017 in the USA and observed that ridesourcing had a negative impact on car ownership. Even though the examined literature provides a thorough account of the sharing economy, the relationship between this trend and vehicle ownership is yet to be explored extensively. Furthermore, Nie (2017) suggests that consideration should be given to if population density affects the use of ridesourcing services in future studies.

2.3.2 Usage Characteristics of Ridesourcing Services

There is much debate about whether ridesourcing services are just another type of taxi service or whether they fall into a different business model category. Research by (Shaheen, 2018) examined the business models of ridesourcing companies and found that these service providers share an asset-light, peer-to-peer model of using personally owned cars. Under the ridesourcing companies' model, companies such as Uber and Lyft do not own any of the vehicles used to provide the services. Thereby reducing the need to have a large inventory of vehicles, equipment, or facilities and most of the product maintenance is centred around their apps (Shaheen, 2020). This also means they hire a limited number of employees since the drivers are considered contractors, which has caused some controversy with the taxation and labour authorities.

Ridesourcing companies argue that they are not transport companies but rather software companies that develop advanced software algorithms that can efficiently facilitate on-demand mobility services by connecting users with available drivers (Sfenrianto, et al., 2019). Moreover, Button, 2020; Wang & Smart (2020) explained that through these algorithms, ridesourcing services tend to serve a two-sided market, the potential users, and driver-partners.

Literature examining the usage characteristics of ridesourcing services is varied and includes some of the earlier studies exploring ridesourcing in North America. In a study investigating the adoption and impacts of ridesourcing, Clewlow & Mishra (2017) studied seven metropolitan areas in the USA using surveys, which found 30% of adults used ridesourcing with a quarter of users using the service weekly or daily, where 37% of users cited 'parking issues' and 33% stated 'avoiding drink driving' as the main reasons for using ridesourcing instead of driving themselves. Furthermore, many users (36%) were younger (18-29 yrs.) compared to only 4% being over 65, and the research also suggests that more 'college-educated', affluent Americans have adopted ridesourcing, twice as many as those from low-income households with less education. This study also found a net 6% reduction in PT ridership and suggests whether ridesourcing complements or competes with PT varies depending on the type of mode. Buses were found to be affected the most (6% reduction), while light rail was also down (3% reduction), but commuter rail gained 3% net increase. They also reported that most of the ridesourcing trips (49% to 61%) would have been made by PT, active modes or not made at all. On this basis, they conclude that ridesourcing is likely to contribute to an increase in Vehicle Miles Travelled (VMT).

Research by Chen (2015) in the USA indicates that social and recreational trips are the predominant type of trips used for ridesourcing followed by work trips; trip lengths are shorter and more frequent with a higher occupancy rate. This research also reveals that ridesourcing users tend to be younger (18 - 24 and 25-34), better educated and higher-earning than the average USA population. The highest percentage (51%) of those surveyed as part of the study reported their trip purposes were to avoid driving while intoxicated, whilst 46% stated it was for social/leisure purposes (e.g., bar, restaurant, concert, visiting friends and family), and 40% were getting to or from the airport. Only 3% of respondents indicated they use ridesourcing for getting somewhere faster than public transport (Chen, 2015). Furthermore, Zhao & Dawes (2016) found that 74% of respondents stated they used ridesourcing services because it was more accessible than PT and concluded the main reasons travellers chose ridesourcing was due to its “convenience”, “speed”, “cost” (cheaper), “safety”, “modern” (trendy) and because friends use it. In terms of convenience, a survey conducted in San Francisco, where ridesourcing was first introduced, estimated average wait time of 2.5 minutes compared to 15 minutes for the traditional taxi (Rayle, et al., 2014) which further emphasises the convenience offered by ridesourcing. According to Brown (2015), ridesourcing has some advantages over owning a car, including avoiding the need for parking and the ability to relax or catch up on work rather than driving. Travellers for whom ridesourcing is a superior alternative to owning a car pay a higher per-trip price for car travel, which provides an incentive to reduce car usage in the same way as carsharing, however, this study does not explore the wider transport policy implications.

Rayle et al (2016) argues that ridesourcing service characteristics differ in terms of user types, wait times, and trips served compared to a conventional taxi and habitual public transport users mainly rely on ridesourcing in certain situations (e.g., during bad weather), therefore allowing for a car-free lifestyle. Some 43% of respondents in this study indicated they did not own a car and 47% of trips started somewhere other than home (i.e., gym and bar.) while 40% were home-based. The main characteristics of a typical ridesourcing service are broadly interlinked and include ‘users’ (i.e., demographics), 'trips' (i.e., trip purpose, time/location) and 'service' features (i.e., cost and safety).

Alemi, et al (2019), studied usage frequencies of ridesourcing in California and found that socio-demographic variables were key factors in service adoption. Nevertheless, that did not clarify the variations in the frequency of use, although land-use mix and densities significantly impacted the frequency of use. This research also found that frequent taxi users (i.e., those who use a taxi once or more a month) were more likely to use ridesourcing than non-frequent taxi users. However, people who use smartphone apps for other travel-related activities were also more likely to adopt and use ridesourcing more often; however, users with safety concerns or those that have higher inclinations to car ownership were less likely to use the service. Research by Young & Farber (2019) examined the usages of ridesourcing and found that users were mainly younger (20 to 39 yrs. old) and wealthier (employed with household earnings of over $125,000 pa), therefore raising the question of equity since only 2.6% of users were found to be from low-income households. Most trips were at night or evening (over 31%), which is when PT ridership is generally low. They also found an important link with PT in that 50% of ridesourcing users indicated having a monthly PT pass. Thus, they concluded that ridesourcing trips were negligible in influencing ridership levels of core transport modes - when considering all trips made using all available modes – but they at the same time acknowledged a reduction in the taxi and active mode trips, due to the use of ridesourcing.

2.3.3 Impacts of Ridesourcing service

In a study investigating whether Uber services complemented or competed with PT in USA cities, Hall et al. (2018) concluded that in general, Uber was complementary to PT where it helped increase ridership by 5% after two years of operations, with the highest increases seen in larger cities and cities with small transport agencies. This finding indicates that Uber mainly entered cities based on population size, starting with large cities. This study found that the flexibility that Uber adds to the city's mobility offering is an important factor as 25-40% of Uber pick-ups/drop-offs were reported to be near PT stations, indicating that Uber could be helping to resolve first/last mile mobility issues. Moreover, a Pew Research Center (2016) study suggested that PT usage to be considerably linked with Uber usage, stating 56% of weekly Uber users also used PT compared to only 9% of non-Uber users.

Earlier research in the USA by Rayle et al (2014) indicates that ridesourcing appears to substitute for and complement public transport; they found the majority of ridesourcing trips would have taken substantially longer if made by public transport. This research showed that ridesourcing serves previously unmet demand for convenient, point-to-point urban travel and that ridesourcing wait times are markedly shorter and more consistent than those of taxis, whilst users tend to be younger, own fewer vehicles and more frequently travel with companions. A study by the Shared-use Mobility Centre (2016) suggests that ridesourcing trips were more likely to substitute for car-based trips than public transport trips. The study asserts that those who prefer ridesourcing tended to be more car-use centred, with 34% reporting they would drive alone or with a friend if ridesourcing were not available, 24% saying they would use carsharing, and only 14% saying they would use public transport instead.

Other research exploring the impacts of ridesourcing are presented, such as (Martin & Shaheen, 2011; Alemi, et al., 2018; Circella & Alemi, 2017; Rodier & Michaels, 2019; Babar & Burtch, 2017; Agyemang, 2019; Kong, et al., 2020; Young, et al., 2020). These studies indicate that ridesourcing services have an effect on PT use by reducing urban bus and tram use and increasing necessity for sub-urban trains. However, Babar & Burtch (2017) argue that such a relationship is governed by many factors, including geographical context, size population, weather conditions, levels of violent crime in that area, fuel prices, the trip distance, and accessibility & quality of available PT options. A study conducted in Chengdu; China showed that 33% of Didi-Chuxing trips could substitute for PT and the rate of substitution was much higher during the day, between 8am and 6pm (Kong, et al., 2020).

Other studies such as (Posen, 2015; Watanabe, et al., 2016; Zha, et al., 2016; Nie, 2017; Berger, et al., 2018; Agyemang)(2019), attribute the adoption of ridesourcing services to the decrease of traditional taxis use. Whilst investigating who ridesourcing is impacting Nie (2017) analysed trip characteristics and found that the rapid spread of ridesourcing services across major cities has resulted in a significant loss of ridership in the traditional taxi industry, similar conclusions were reached by Shaheen (2020) in the course of investigating shared ridesourcing services conducted in San Francisco. For example, this study found the launch of UberX and Lyft in San Francisco in 2012 resulted in a 65% drop in the number of traditional taxi trips between 2012 and July 2014 and two years later, Yellow Cab, a leading taxi company in the city went bankrupt. However, (Nie, 2017) found that traditional taxi competes more efficiently with ridesourcing services during peak times and in high-density areas. Furthermore, Rogers (2015) questions how and why ridesourcing services are allowed to operate in the same market with a traditional taxi but are subject to different regulations. The unregulated nature of ridesourcing services tends to undermine traditional taxi services and increase the substitution rates to ridesourcing.

Schaller (2017), investigated the impacts of ridesourcing services on traffic conditions in Manhattan (New York) and found between 2013 and 2017, the number of ridesourcing and taxi vehicles in the central business district increased by 59%. Moreover, passenger trips increased by 15% with most passenger trips occurring late afternoon/early evening (4 pm to 6 pm) and vehicles miles increasing by 36% while traffic speeds decreased by 15%, which all points to a significant impact on traffic conditions from ridesourcing and taxis. This study also found that ridesourcing and taxi vehicles are driving in the city without passengers approximately 45 VMT out of every 100 VMT and suggests the need for new policy measures to tackle this issue.

Other studies examining the effect of ridesourcing on traffic crashes, congestion, and pollution are also found in (Schaller, 2018; Circella & Alemi, 2017; Clewlow & Mishra, 2017; Nie, 2017; Conway, et al., 2018; Schwieterman & Smith, 2018; Erhardt, et al., 2019; Lavieri & Bhat, 2019; Button, 2020; Shokoohyar, et al., 2020). These studies indicate that the introduction of ridesourcing services has led to an increase in traffic congestion, although the levels of impact and causal factors are inconsistent. Moreover, Erhardt et al (2019), examined whether ridesourcing services decreased or increased congestion, using data obtained from two ridesourcing providers in San Francisco. The study concluded that ridesourcing had contributed the most to growing traffic congestion in the city and noted that trip times of journeys entering the city centre was higher than those leaving, which was attributed to congestion caused by too many ridesourcing vehicles. However, Malodia & Singla (2016) and Circella & Alemi (2017) highlight that the greatest public benefit of ridesourcing would come from shared options (i.e., Uberpool), which would help to reduce congestion. Moreover, Deakin et al. (2012) and Hou et al. (2020) found that although the popularity of ridesourcing services increased congestion in cities, the shared ridesourcing services effectively reduced congestion. Ridesourcing drivers seeking users or parking space in the city are also contributing to the congestion problem (Button, 2020). Implementing a congestion surcharge to enter the city centres has been publicised as a potential solution to the growing congestion, for example, New York city began applying a surcharge in 2019 (Wang & Smart, 2020) and London in 2020 (TFL, 2020).

Additionally, research by Greenwood & Wattal (2017) explored the public welfare implications of ridesourcing by examining how these services influenced drunk driving and related vehicle casualties and found that there was a substantial reduction (3.6% to 5.6%) in the rate of drunk-driving related deaths after UberX was introduced in California. Furthermore, Peck (2017) investigated the effect of Uber on drunk-driving related car crashes in New York City and estimated a decrease of 25-35% in alcohol-related crash rates between 2011 and 2013, further highlighting the potential that lies within ridesourcing services in terms of public welfare benefits and saving of lives.

2.4 Ridesourcing (including Shared Ridesourcing) Services in Transport Policy

Introduction

This sub-section offers a review of recent literature on ridesourcing services in transport policy and governance. Also, the regulatory challenges and policymaking implications resulting from the emergence of shared and non-shared ridesourcing services are discussed. Moreover, the identified research gaps and subsequent research questions are provided.

Ridesourcing Services in Transport Policy

Review of previous literature shows that studies addressing the policy or governance relating to ridesourcing services are limited, as recognised by (Edelman & Geradin, 2016; Agyemang, 2019). Whilst exploring the policy implications of the Uber and local taxi issues in Accra, Ghana, Agyemang (2019) discussed regulation number 95 and explains that ridesourcing companies are often viewed as offering taxi services due to the fare that users pay. According to the regulation, the word “taxi” denotes a motor vehicle meant to carry a maximum of five people, including the driver and either used or planned to be used for purposes of hire or reward. However, according to Edelman & Geradin (2016) and Agyemang (2019), there appears to be a total disregard for such regulations considering that ridesourcing vehicles are commonly not licensed to run a traditional taxi service, the vehicles are unmarked and drivers do not belong to any union. Moreover, these services often circumvent the taxi regulations by maintaining that they are not a transport company, but rather a technological platform.

Schwieterman & Smith (2018) described some of the issues resulting from compliance or noncompliance with the regulations set by local authorities. Furthermore, other studies such as Edelman & Geradin, 2016; Rogers, 2015; Jin, et al. (2018) explain some potential social costs created by ridesourcing services, such as reduced level of safety due to lack of driver certification and training and loss of privacy due to possible cases of user data exploitation. Moreover, Rogers (2015) highlighted that there were no adequate policies to minimize discrimination among ridesourcing services. For instance, drivers in Chicago, Illinois and many other parts of the USA can reject requests from certain neighbourhoods, which is an act of discrimination. How to prevent such discrimination is an issue that researchers and policymakers need to explore and find a balanced consensus that addresses the safety concerns of ridesourcing companies and discrimination of users.

In terms of transport policy in relation to the impact of ridesourcing on public transport Standing et al. (2018) stated governments must invest in long-term transport infrastructure and policies that may impact the future demand of ridesourcing and public transport services should be monitored and researched. This is important since it can influence mode choice and decisions on car ownership (Posen, 2015; Standing, et al., 2018; Li, et al., 2019). According to Lavieri & Bhat (2019) policymakers should focus more on directing people's acceptance and use of shared ridesourcing as an "accessibility or convenience" mobility tool. The success of such policy initiatives is dependent on shared ridesourcing serving various people that use a similar route and the potentially reducing VMT (Lyons & Davidson, 2016; Lavieri & Bhat, 2019). Furthermore, positive adoption of these services has focused on the potential of ridesourcing acting as a steppingstone for an integrated, multi-modal, and service-based mobility in cities (Lavieri & Bhat, 2019). According to Malodia & Singla (2016), shared ridesourcing supports energy efficiency and emission reduction policies and is supported by the Petroleum Conservation and Research Association (PCRA). In addition, Furuhata et al. (2013) and Young et al. (2020b) highlighted that the potential of shared ridesourcing helping to greenhouse gas emissions (GHG) and traffic congestion had got the attention of policymakers.

The reviewed studies indicate that the rapid growth of ridesourcing services poses many benefits and challenges for policymakers and transport authorities. The key factors shaping the use of new shared-mobility services and the possible effects on other elements of travel are still mostly uncharted (Rogers, 2015; Circella & Alemi, 2017; Jin, et al., 2018). In some cases, these shortcomings are induced by the lack of data on users, understanding the nature of ridesourcing services, uncertainty over the change in regulations and services work, and differences in usage across different geographical context (Rogers, 2015; Circella & Alemi, 2017; Jin, et al., 2018; Schwieterman & Smith, 2018; Standing, et al., 2018). According to Dudley et al. (2017), ridesourcing companies such as Uber and Lyft have obtained significant success globally by out manoeuvring regulators, transport agencies and traditional competitors. Moreover, Bekka et al. (2020) acknowledge that new policy measures are needed that guide the development of effective strategies for shared mobility.

Policy implications

There is limited literature addressing the transport policy aspect of ridesourcing services, especially shared ridesourcing. Particularly research addressing the operational and policy aspects of these new services is limited. As a result, the lack of adequate policy measures for ridesourcing services has resulted in various consequences. With such a vacuum in policy and regulations, policymakers and regulators have reacted in several ways to the spread of these services. For instance, Uber and Lyft drivers in New York City must register and get a license (Ranchordas, 2016; Jin, et al., 2019). This is against the trend in many other cities where ridesourcing service drivers have no contact with local regulators and work without considering the regulations governing traditional taxis (Wallsten, 2015; Ranchordas, 2016). Regulators in Berlin decided not to allow Uber to provide unrestricted peer-to-peer services, a move explained by public safety concerns (Ranchordas, 2016; Jin, et al., 2019). The upholding of this decision has established Uber as a typical simple taxi (albeit using a hailing platform) (Ranchordas, 2016). Despite these challenges, ridesourcing companies remain undiscouraged by judicial challenges and continue to push the boundaries of regular taxi and private hire regulations.

Following claims by ridesourcing services that their drivers are independent contractors operating their business, some cities have moved in to address this concern. For example, in San Francisco, authorities require drivers to apply for a business license (Rayle, et al., 2014; Ranchordas, 2016). This requirement applies to all Uber and Lyft drivers if they drive for at least seven days a year. Further, regulators have put in place mechanisms to ensure the driver's information is evident on a database openly available. The increasing use of these platforms together with recent concerns about the safety and privacy of user illustrates that self-regulation may not be sufficient to deal these novel services and therefore several scholars suggest the need to address the sharing economy from a new point of view that considers their economic model of operation and its impact on other services and society (Penn & Wihbey, 2016; Ranchordas, 2016).

An important challenge for policymakers and the transport sector, is how these new mobility services like shared ridesourcing will or should be governed not only in terms of the transport authorities' policy and actions. But also, in a broader sense, dealing with processes where problems are identified, and suitable measures are developed and implemented, that achieve favourable outcomes and prevent unwanted ones for cities (Dowling, 2018). Moreover, concepts such as mobility as a service (MaaS) of which ridesourcing is a component, provide fundamental challenges to urban transport authorities, including that of 'uncertainty', where technological development and associated impacts heading; and how to deal with and assign liabilities between the various stakeholders such as users, service provider, authorities (Pangbourne, et al., 2018).

Furthermore, Docherty (2018), investigated new governance challenges for new smart mobility services and concludes that minimizing the need to travel has been a key aim from transport authorities as part of many sustainable transport measures. However, there needs to be thorough debate and discussion on how the transition to new mobility might be governed so to benefit society and the environment, whilst reducing any negative impacts. However, this is very difficult, he argues, when there is no ‘real world’ quantification of the impacts of new mobility services (such as ridesourcing). Therefore, to provide effective governance to smart mobility transition, clear regulatory frameworks (e.g., on data sharing, taxation, equity), standards and roles of stakeholders need to be agreed upon (Docherty, 2018). Nevertheless, steps should be taken to ensure too much regulation does not stifle innovation and, therefore, transition to new mobility services such as ridesourcing. Additionally, Docherty, et al. (2018) highlight the key challenges and suggest that effective governance is needed not only to steer and facilitate new mobility services but also to reject elements that conflict with public benefit.

2.4.1 Gaps in Literature

A comprehensive review of the current body of literature on ridesourcing and other related shared mobility services reveals three important gaps:

Firstly, most of the existing literature on ridesourcing is based on studies undertaken in North America, particularly USA and the findings do not fully address the complex, policy, and operational issues relevant to a European or UK city. Furthermore, it is not evident whether findings related to North America context are directly transferable to the UK or a European context considering the contrast in reliance on personal car use and public transport accessibility. Also, there is limited consensus in current literature about the role of ridesourcing on the broader transport ecosystem, and it is not clear whether there is a need for similar or different approaches for a European and American context. As such, context-specific empirical evidence is needed to understand ridesourcing services including, how the services are used, by whom and for what trip purposes, to support transport authorities and policymakers in developing suitable policy measures to manage the effects of these new mobility services on the transport network.

Secondly, shared ridesourcing such as Uberpool is not adequately addressed in the current body of literature in terms of its effect and relationship with PT services, even from the North American perspective. Although service providers, such as Uber, market shared ridesourcing as being beneficial for users and the cities (where it operates) due to the sharing (pooling) nature, it is not well understood, and there is no common approach on how these services should be managed or regulated. Therefore, it was important to understand how shared ridesourcing operated and its effect on other modes such as PT whilst taking into account the perspectives of key stakeholders.

Thirdly, previous studies fail to consider the viewpoints and inputs from all key ridesourcing services interested parties, for example, the users, drivers, service providers (TNCs), policymakers and transport authorities, experts, and other transport mode operators; and largely relied on single perspective such as users or drivers only. However, it is essential to study all interested parties' inputs and viewpoints to fully understand the operational and policy implications of ridesourcing, specifically shared ridesourcing, such as Uberpool, and the broader implications of these novel services on cities' current and future mobility options.

Considering all interested parties' perspectives is essential in policymaking, especially when there are wide-ranging stakeholders involved in the provision, usage and management and regulation of these services. Therefore, independent empirical research that examines viewpoints is needed to offer evidence-based support for the approaches transport authorities and regulators should take to deal with or manage such services.

2.4.2 Research questions

The growth of shared ridesourcing services such as Uberpool in cities worldwide is having a disruptive impact on conventional public transport and taxi services. The rapid growth is creating challenges and opportunities for transport authorities and policymakers who so far have been slow to respond to policy and operational demands for these new mobility services. This study aims to develop an understanding of ridesourcing services usage characteristics and how such services work with public transport modes, in addition to exploring the implications of Uberpool on conventional public transport, in terms of policy and operation.

To achieve the research aims and contribute to the body of knowledge on ridesourcing (in general) and shared ridesourcing, specifically, the following research questions have been formed, as shown in Table 1. These research questions will help fill the main research gaps identified in this study by providing a comprehensive UK and European case study whilst focusing on shared ridesourcing and its implications by capturing the viewpoints from primary ridesourcing service interested parties.

Table 1. Research Questions

1	**How are UberX and Uberpool currently used in a city like London?**
	a) How frequently are these services used and by whom?
	b) When are UberX and Uberpool used and for what trip purposes?
	c) What modes has Uber replaced?
	d) Are Uber services affecting car ownership?
2	**What attracts people to Uberpool in a city like London?**
	a) What is the socio-demographic profile of Uberpool users compared to UberX users?
	b) Why do people use Uberpool instead of UberX and traditional taxis?
	c) Why do people use Uberpool instead of Public Transport and Active modes?
3	**How do transport authorities, and the conventional public transport industry deal with Uberpool in a city like London?**
	a) Do transport authorities and policymakers understand the impact of Uber services in generally and specifically Uberpool?
	b) How are the transport authorities and PT sector dealing with shared ridesourcing services?
	c) Do transport authorities in London have any existing mechanisms for monitoring impact of Uber services?

2.5 Literature Review Chapter Summary

This chapter presented the findings from a thorough literature review of the research relating to the broader topic of transport innovation, shared and smart mobility, Mobility as a Service, the sharing economy and transport and traditional for-hire (taxi) services to set the context for this research. The literature review then provided a more focused appraisal of the current state-of-the-art on ridesourcing services, its impacts on PT, how they are used, and the policy implications of ridesourcing services emphasising on shared ridesourcing. An extensive literature review was undertaken, which included earlier published literature and more recent publications in addition to important books (and book chapters) and reports on the topic.

Current literature illustrated that ridesourcing is part of growing shared mobility, which has thrown up many challenges and debates from policymakers, users, and operators. Until recently shared ridesourcing has been under-researched, mainly due to limited data availability on important elements such as its impacts and usage characteristics and the rapid pace of development. Moreover, there were indications that ridesourcing is affecting other modes, including traditional taxi and PT, but impacts from shared ridesourcing are less understood and related policies and regulations are limited.

The majority of previous studies found were undertaken in North America, and it is unknown how transferable the findings are to a UK context. Earlier studies indicate that the key factors in service adoption included the socio-demographics of users (users are commonly tech-savvy, young and well educated), convenience, and cost. Another important factor driving the growth in ridesourcing is changing attitudes towards ownership and sharing. Additionally, the sharing economy is enabling people to use technology platforms to share many things, including cars, indicating that younger people are valuing technology and sharing over car ownership. Previous research emphasises the need to consider the impacts and policy implications of shared ridesourcing such as Uberpool on mobility, society, and safety.

There are useful lessons that are drawn from the current literature on ridesourcing and other shared mobility services. However, most of the current case studies do not adequately address the complex operational and policy implications of ridesourcing, specifically in relation to shared ridesourcing services such as Uberpool. Transport authorities are still struggling to regulate and effectively manage these new services and there is little evidence about any synergy between policymakers and the transportation network companies who operate ridesourcing services. There were three primary research gaps identified from the literature review on ridesourcing services, as detailed in Section 2.4.1.

Furthermore, this is the first study, investigating shared (Uberpool) and non-shared (UberX) ridesourcing services in the UK and European cities context. Therefore, it is important to obtain insights and empirical evidence on how ridesourcing services are used, by who and for what trip purposes in London. In addition, this study adds to the current debate and understanding on the implications of ridesourcing services on conventional PT modes and trip making characteristics, hence supporting transport policymaking. As shown in Section 2.4.3, a set of research questions have been developed to achieve the overall research aim and help fill the discovered research gaps. The next chapter will discuss the methodology adopted for data collection and explains the methods used for the data analysis for this study.

Chapter 3: Research methodology

3.1 Introduction

For this study, a mixed-methods approach was adopted, which involved the collection of quantitative and qualitative data, to achieve the research objectives and answer the research questions set out in Chapter Two of this thesis. The primary quantitative data were collected using a questionnaire, while the qualitative data was collected using interviews and focus groups. These methods are commonly used in transport research because quantitative methods are useful for obtaining data from controlled settings or specific groups using revealed or stated preference approaches. In contrast, qualitative methods are helpful to explore social issues by analysing the different perspectives of participants' experiences and views.

This chapter explains the research methods used in transport studies and the methods adopted to collect and analyse data for this research. Moreover, it discusses the rationale for selecting London for this study and addresses the research ethics considerations, closing with a brief chapter summary.

3.2 Data Collection Methodology

Studies investigating transport usage and the perspectives of policymakers and other key stakeholders require data about why and how the services are used, implications of the services being studied, and viewpoints of all interested parties to build a full picture. The methods used in transport research include the collection of qualitative and quantitative data, using data collection approaches such as stated preference and revealed preference in the form of surveys, interviews, and focus groups.

Qualitative and Quantitative Methods

The two primary methods used in transport studies and generally in empirical research are qualitative and quantitative methods. Although the actual research (data collection and data analysis) may involve a variety of individual methods for both qualitative and quantitative approaches, there are basic differences between the two methods. Quantitative methods are most suited in cases where a positivistic approach is undertaken (Moser & Kalton, 2017; Patriksson, 2015). A positivistic approach is required when the research aims to obtain data from controlled settings, as in the case of experiments, or when the inputs are to be obtained in a substantially structured manner, as in the case of multiple-choice surveys. Data is usually collected using structured questionnaires or in a laboratory setting, which can be quickly disbursed to obtain the responses from many people.

However, qualitative methods are more conducive to a phenomenological research approach (Lewis, 2015), which is more suited to cases where the need is to obtain rich and contextual (but sometimes subjective) inputs from the participants. Qualitative data is usually collected using several methods such as document analysis, participant observations, focus group and one-to-one interviews, accompanied interviews, paired interviews, or brainstorming and mini groups (Browne & Ryan, 2011). This approach is more suited to cases where the need is to obtain rich and contextual, often subjective, inputs from the participants. This is appropriate when the research participants are an authority over the subject or where it is important to consider the context and subjectivity of the situation to understand the dynamics of the variables (Lewis, 2015).

The use of qualitative and quantitative methods is found in transport studies, depending on the research aims and focus of the study. Within transport research, some quantitative studies have aimed to understand the issue of transport from a logistical or operational perspective and hence used methods to capture data that could reveal inefficiencies and wastages of time and resources. For example, Stiglic, et al. (2016) undertook a computational study to understand the impact of participant's flexibility on the performance of driver; also, Froehlich et al. (2009) used a field study enlisting user activity on a transport display prototype that allowed them to gauge users' inclination to use green transport.

On the other hand, qualitative research in transport studies has focused on issues such as the perspective of the commuters, policymakers, and other stakeholders from the stance of a social-personal viewpoint (Cascetta, et al., 2015). Interviews are a common qualitative data method in transport studies as they provide a chance to obtain information from people who are either experts or stakeholders in the system (Browne & Ryan, 2011). For example, Shaheen et al. (2012), used expert interviews to explore personal carsharing in North America as part of their research on the sharing economy and Anderson (2014), used ethnographic interviews to explore the motivations and strategies used by ridesharing drivers in California. Qualitative methods are used in cases where the study aims to improve efficiency, sustainability, or effectiveness of the systems and expert opinions or the opinions of other stakeholders are of crucial importance. Whereas, quantitative methods may be useful in instances where the objective is to test efficiencies of the systems, but these also sometimes need to be further validated and supported with qualitative methods (Browne & Ryan, 2011).

Both methods have certain advantages and some limitations. For example, qualitative methods require interacting with each research participant in a relatively longer timeframe than what may be needed for conducting a survey to collect quantitative data (Moser & Kalton, 2017). Moreover, it is a time-consuming method and limits the number of people that can be involved in the research because the data is collected from personal observation or focus group or interviews, which requires an effective interviewer who can elicit maximum information (Browne & Ryan, 2011), although it does lead to more in-depth and comprehensive data (Marshall & Rossman, 2014). The interpretation of the qualitative data to infer information and meaningful knowledge is often complicated and prone to subjective bias. The interpretation of quantitative data suffers less from these problems, as it is amenable to statistical analysis and mathematical interpretation, which yield objective findings (Lewis, 2015).

For this research, both qualitative and quantitative methods have been adopted. The qualitative approach was adopted using a combination of focus group and interview data were deemed the most suitable method as these provide a closer interaction with the participants and provide greater freedom and privacy to them to give their opinions. This method helps to obtain valuable data that included expert opinions and insights from experts, operators, policymakers, Uber drivers, and other key stakeholders. Furthermore, the quantitative approach was implemented using a survey of Uber users in the Greater London area to collect important data on how, why, and when Uber services are used and what effects these services are having on other modes. To answer the research questions detailed in Chapter Two, the following data collection methods were applied, as shown in Table 2.

Table 2: Data collection methods to answer the research questions

		Method		
No:	**Research Questions**	**Surveys** *(Uber Users)*	**Focus groups** *(Uber Driver)*	**Interviews** *(Stakeholders)*
Q1	**How are UberX and Uberpool currently used in a city like London?**			
	e) How frequently are these services used and by whom?	✓	✓	
	f) When are UberX and Uberpool services used and for what trip purposes?	✓	✓	
	g) What modes has Uber replaced?	✓		
	h) Are Uber services affecting car ownership?	✓		
Q2	**What attracts people to Uberpool in a city like London?**			
	a) What is the socio-demographic profiles of Uberpool users compared to UberX?	✓	✓	
	b) Why people use Uberpool, instead of UberX and traditional taxi?	✓	✓	
	c) Why people use Uberpool, instead of PT and Active modes?	✓		
Q3	**How do transport authorities, and the conventional public transport industry deal with Uberpool in a city like London?**			
	a) Do transport authorities and policymakers understand the impact of Uber services in generally and specifically Uberpool?			✓
	b) How are the transport authorities and PT sector dealing with shared ridesourcing services?			✓
	c) Do transport authorities in London have any existing mechanisms for monitoring impact of Uber services?			✓

Revealed Preference and Stated Preference

The common data collection methods used in transport research include Revealed Preference (RP) or Stated Preference (SP). RP based studies allow researchers to examine travellers' actual choices and characterise how people really travel; therefore, it is more realistic compared to SP, but it is challenging to obtain data on participant activities that cannot be observed. In comparison, SP based studies allow the researcher to examine how people's choices might change if there are changes in the alternatives available (Ahern & Tapley 2008). Accordingly, SP approaches offer higher levels of validity. SP approach offers a quick and flexible way of undertaking data collection for empirical research in transport as it is easier to administer. Moreover, it allows researchers to offer hypothetical scenarios to the participants to gauge how their travel behaviours or views might change based on scenarios that could be future or present (Kroes & Sheldon, 1988).

Furthermore, SP methods present an opportunity to explore the potential impacts of a particular service or transport mode based on feedback (i.e., responses on the hypothetical scenarios) from participants (Dia & Panwai, 2010).

Studies using RP approaches incline to be more time consuming and, therefore, difficult to obtain a high response rate. Relevant previous studies that have used the RP approach include (Le Vine, et al., 2011; Le Vine, et al., 2014; Clewlow & Mishra, 2017; Martin & Shaheen)(2011a). In addition, earlier studies that utilised SP methods include Ho, et al., 2020; Circella, et al., 2019; Malodia & Singla, 2016; Davidson, et al., 2014; Kamargianni, et al., 2018; Matyas & Kamargianni, 2019; ITF, 2017; Hou, et al. (2020). Moreover, other relevant studies used combined SP and RP methods such as Kang, et al., 2021; Hensher, 2008; Dissanayake & Takayuki, 2010; Ahern & Tapley, 2008; Espino, et al. (2007).

To examine the use of shared ridesourcing services such as Uberpool and comprehend its implications on traditional modes of transport requires an understanding of underlying factors about why travellers use ridesourcing as a mode of transport and for what trip purposes in cities such as London, which has many transport options available. Moreover, it is important to obtain the viewpoint from policymakers, experts/academics, transport operators and ridesourcing drivers to get a comprehensive set of data for the research. Accordingly, for this study, a combination of qualitative and quantitative data was collected from three primary sources, using mixed RP and SP methods. The primary data sources are intercept survey data from Uber users, focus group data from Uber drivers and Interview data from policymakers, PT operators, industry experts and ridesourcing service providers.

3.2.1 Interviews with policymakers and other stakeholders:

Interviews are best used for finding out attitudes and perceptions, particularly for complex concepts. Interviews generally have high-quality response rates but are expensive and time-limited to conduct, and extra effort needs to be made to minimise interviewer bias (Richardson, et al., 1995). Interviews are an important element of this study and were used to collect data from transport policymakers, experts, operators, and service providers to get a holistic view from all interested parties.

Interviews were selected as a suitable data collection method because it allows the investigation of issues more deeply, as each participant can give detailed and subjective information. People can freely express their feelings, thoughts, and attitudes without the fear of being exposed to others' judgement (as in the case of focus groups). In addition, the very nature of interviews allows the researcher to dig deeper if he/she wants and to ask more questions to enable clarity (Larsen & Urry, 2006; Urry, 2016). It is also easier to record information received in the interviews as it is delivered in a cogent one-to-one manner. Interviews also allow the researcher to observe the respondent's body language and non-verbal cues, thus giving additional contextual cues for data interpretation (Wethington & McDarby, 2015). Although interviews are extensively used in transport research, for example (Anderson, 2014; Shaheen, et al., 2012), the main disadvantage is that its time-consuming, which may restrict the total number of participants that can be included in the research. Also, a trained interviewee is needed so that they do not ask leading questions or influence the interviewee in any way due to personal bias (Creswell, 2015).

Interview data were collected from policymakers, experts, transport operators, researchers and innovators, using semi-structured interview format, which is a common data collection method and is a frequently used interview technique in qualitative research (Kallio, et al., 20016; DiCicco-Bloom & Crabtree, 2006), mainly due to its versatility during the interviews. These types of interviews are valuable for accommodating a range of research goals and can incorporate both open-ended and more theoretically driven questions to get data based on the experience of the participant as well as data guided by existing paradigms (Galletta, 2013). This was particularly useful for asking additional follow-up questions to gain further insights or explanations.

As part of the interview template design process, pilot interviews were undertaken with nine different participants to test the interview plan and the draft semi-structured guiding questions. This was also used to get feedback about Uber services and understand the ease with which the participants understood the questions. The outcome of the pilot interviews was used to develop the final interview question templates.

The interview templates were developed prior to commencing the interviewee recruitment process and were informed by the main research questions and initial pilot interviews; the list of guiding questions and `what if` scenarios used for the interviews are shown in Table 3.

The recruitment of interviewees was done in different ways, mainly through industry contacts or local transport authorities and operators. A list of potential participants was compiled and initial contact with potential interviewees was made either by telephone or by an introductory email. All willing participants were followed up with an email containing a research brief, an interview template and consent. Interviews were scheduled based on the participants' availability and their preferred method (i.e., face to face or via Skype) to conduct the interview. The interviews were undertaken in a semi-structured format, either face-to-face, via Skype or by Telephone and the location of the interviewees at the time of interviewing included London, Milton Keynes, Edinburgh, Surrey, Stockholm (Sweden) and California (USA). The interviews were completed over 12 weeks, starting from 17th July 2017. All interviews were recorded and then later verbatim transcribed.

Table 3: Interview Guiding Questions

1. What are your views/understanding regarding Uberpool and its impact?
2. Are there any existing or planned regulations for ridesourcing services such as Uberpool?
3. How do local/regional Transport Authorities currently deal with Uber operations and are there any guidelines or limitations provided to Uber?
4. Has there been any issue arising from Uberpool operations since its launch?
5. Are there any local policies that help or hinder Uberpool operations in London?
6. Is there any data to show the impact of Uber on congestion since its launch in London?
7. Do you have or know any plans for dealing with ridesourcing services as part of future transport system?
8. Are there any existing mechanisms to monitor the impact of Uberpool on public transport or congestion? Are there plans to develop this?
9. How have you (transport authorities/policymakers) previously dealt with disruptive or big impact innovations?
10. How are drivers' rights protected or regulated?
11. What are your views about Uber services in general? Has Uber been a positive or negative addition to the City's transport system?

Table 3: Interview Guiding Questions (continued)
Interviewees were provided with the below 'what if' scenarios to gather further insights and perspectives, where participants were asked: "How they thought the following scenarios should be managed/dealt with from their perspective and what they thought ought to happen?" • Scenario 1: "If the introduction of Uber is adding more cars to the road and creating more congestion and emission". • Scenario 2: "If Uber is reducing car ownership in one hand but taking customers away from public transport (both bus and rail) on the other hand". • Scenario 3: "If Uber started to offer other shared transport services for example demand responsive van/min bus transport services. Or some type of MaaS, where the use of Uberpool and UberX are central".

The interview questions were organised into four dominant themes during the interviews, as illustrated in Figure 1, to answer key research questions from different viewpoints depending on the background of the interviewee. So that sufficient information and the general attitudes from policymakers and other stakeholders can be obtained to understand how ridesourcing in general and Uberpool specifically are affecting transport services in London, both positively and negatively.

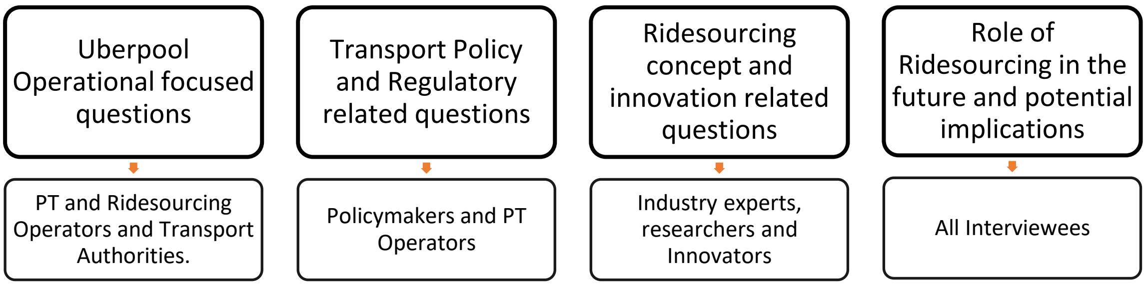

Figure 1: Interview data collection themes

Some 31 different transport policymakers, transport operators, innovators, industry experts, and service providers were interviewed to understand what transport authorities, PT industry and other stakeholders know about and or are doing regarding the emergence of ridesourcing services. Although organisations such as TfL, DfT and Uber were explicitly chosen to obtain their perspectives, the other interviewees that represented organisations outside of London were selected because of their expertise and industry experience. Table 4 lists the different organisations that interviewees represented and their role. This included Transport for London (TfL) which had representatives from four different departments.

Table 4. List of organisations and Interviewee roles

Organisation	Role of Interviewee	Organisation	Role of Interviewee
Transport for London (TfL)	Policymakers, Regulator and Experts	National Express	Operator
Department for Transport (DfT)	Policymaker and Expert	Stagecoach	Operator
Transport Systems Catapult	Innovator and Expert	Lothian Buses	Operator
Urban Transport Group	Policymaker and Expert	First Group	Operator
Transport for Edinburgh	Policymakers and Regulator	Tower Transit	Operator
International Association of Public Transport (UITP)	NGO, Experts, sustainable transport advocates	UC Berkeley	Subject Matter Expert/Researcher
Confederation of Passenger Transport (CPT)	NGO, Experts, UK bus industry advocates	University College London (UCL)	Subject Matter Expert/Researcher
Milton Keynes Council	Policymaker, Regulator and Experts	Imperial College London	Subject Matter Expert/Researcher
Uber (UK)	Ridesourcing service provider/TNC	Transport Studies Unit (TSU), Oxford	Subject Matter Expert/Researcher
Hertz	Innovator/service provider	Keolis	Operator

The composition of the interview participants was broad. It included all key stakeholders, including local transport authority, transport regulators, PT operators, and service providers (i.e., Uber), which provided the opportunity to obtain a diverse set of views on ridesourcing and its wider implications. The profiles of the interviewees are shown in Figures 2 & 3.

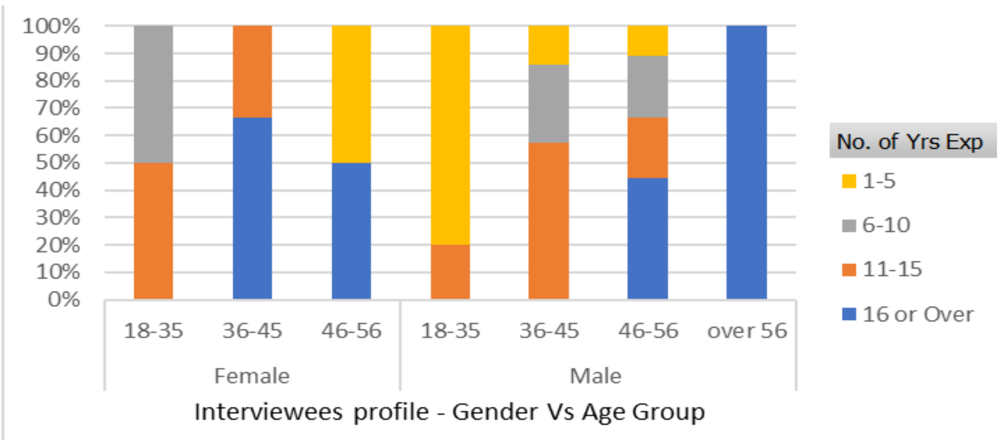

Figure 2: Interviewee profile - Gender/Age/ yrs. of Exp.

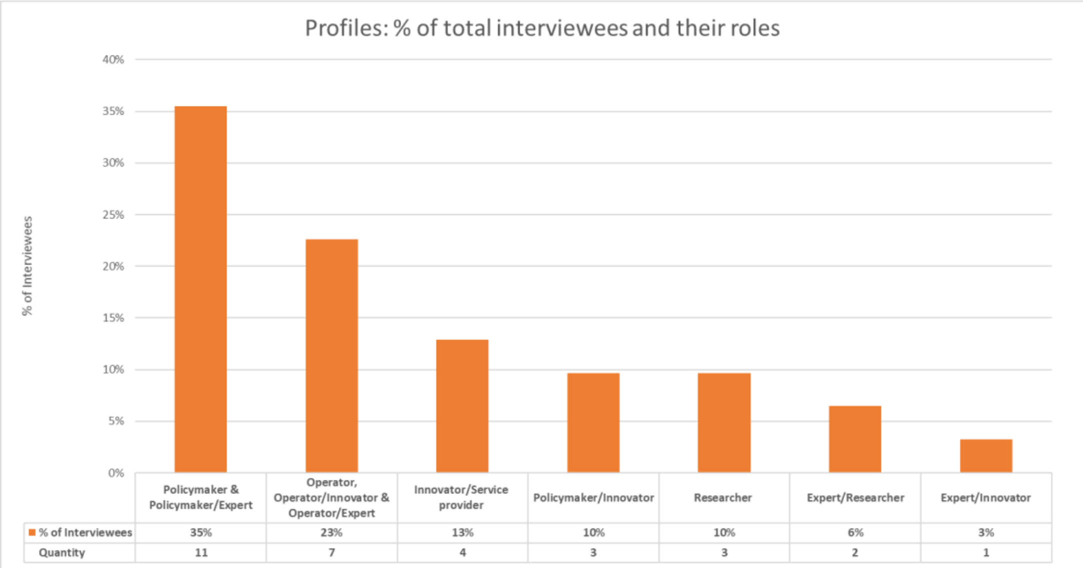

Figure 3. Interviewees profile: % of total interviewees and their roles

Most interviewees were male, aged between 30 to 56 years old and have worked in the transport industry for over ten years with varied roles. Also, the older the interviewee, the more industry experience they had. The only relevant stakeholder that was contacted but not represented during the interviews was ComoUK (formally Carplus), a shared and on-demand mobility provider, and Viavan, who started offering shared ridesourcing services in London after the data collection stage of this research was completed. However, views of ridesourcing service providers were represented by Uber UK, Hertz, and Tower Transit.

3.2.2 Focus Groups (FG)

The focus group data collection method generally involves a small number of people (usually between seven and nine) who are specifically recruited based on predetermined criteria, experiences, attitudes, and beliefs about a particular issue. Depending on the study objectives, the participant criteria may be that the group be similar (i.e., all Uberpool drivers) or dissimilar (for example, to include professional drivers, regular drivers and those who do not have a driver's license). A trained moderator usually facilitates the focus group sessions. Focus groups have some advantages, including a group environment (everyone in the same boat) being less intimidating than a one-on-one in-depth interview and the ability to obtain spontaneous responses to discover insights, which may not be available from individual interviews.

Focus groups were used for this research as it allows participants to present their opinions and suggestions in a way that allows for the generation of ideas and evaluation of problems. This method is often used in the context of transport studies as it helps to reveal additional insights about a given problem and are especially useful in the context of policymaking (Shaheen, 2016). Focus groups are frequently employed to gain a deeper understanding of the given problem under research.

Focus group data collection methods also help in arriving at a large variety of alternative solutions or in exploring diverse aspects of a problem or seeing a given issue from several perspectives (Carey & Asbury, 2016). Another advantage of the focus group method is that it can be conducted in limited time and with limited resources, especially compared to the individual interviews that may require much more resources (Creswell, 2015). However, a limitation of focus groups is that it requires a moderator who can minimise digressions and encourage all participants to voice their opinions and avoid groupthink. Focus group situations may also be intimidating to some participants, and to others, this may trigger a confrontation between participants (Krueger, 2014). Moreover, one participant's strong personality may distort other group participants and there is the possibility of participants losing perspective and getting too emotionally close to the issue being discussed (Richardson, et al., 1995).

Accordingly, focus groups may be utilised as complementary to other qualitative research methods, like participant observation or mixed-method research and surveys (Gerike, et al., 2016). Moreover, focus groups enable a researcher to get a live and dynamic view of how a specific group thinks about the topic, the variations in the opinions of the individual participants and how other participants may influence them. However, focus group participants need to be selected carefully to ensure that the participants are those who are involved in the problem or who have an interest and ability to contribute information about the subject (Soria-Lara & Banister, 2017).

Focus groups were utilised for gathering data from the Uber drivers in London, since they are an important stakeholder in providing ridesourcing service and because this method was the best way to collect sufficient data and viewpoints from a group of Uber drivers in a limited timeframe since most of the drivers work different hours and have other commitments when not working.

The focus group participants were recruited through other Uber drivers in three different areas of London to ensure adequate geographical coverage. The drivers were all full-time Uber drivers, and they served all areas of London throughout the week.

The recruitment process for focus group participants involved speaking with an Uber driver (during an Uber trip in central London) at the initial pilot stage to check the possibility of the driver taking part in a focus group to give feedback about the research topic. This resulted in the driver agreeing to take part in the discussion and he also provided several Uber driver meeting-points (e.g., café) where drivers usually meet to take breaks. Moreover, the driver invited other drivers in his (social media) network to take part if they could. Subsequently, Uber drivers were approached at their meet-up locations over two weeks to explain the research objectives and ask if they would voluntarily participate in a focus group session. Consequently, a total of 28 Uber drivers (in three groups) were recruited and the dates, location and timings of each focus group session were discussed and agreed upon with participants based on their availability.

Prior to starting the focus group data collection process, a draft focus group template was developed that included draft guiding questions and important points that needed to be covered during the sessions. Furthermore, to test the focus group guiding questions, an initial pilot meeting was conducted with 5 Uber drivers to get feedback from the Uber drivers and gauge the ease of using these questions in a group setting and the estimated time needed. The outcome of the initial meetings was used to inform the finalise focus group session templates.

Data was collected from three focus group sessions, involving 28 different London-based Uber drivers – using a set of guiding questions – to understand their views about Uberpool and Uber services in general, including Uber operations, welfare, regulations, terms & conditions they have with Uber and about the service they provide. The guiding questions used are shown in Table 5, although participants were free to, and often did, deviate from these. The focus group sessions were conducted during weekdays in South, East and West London locations, between 13.00 and 16.00, when demand for Uber is generally low, where each session typically lasted 30 to 45 minutes. All focus group sessions were recorded and verbatim transcribed afterwards.

Table 5: Focus Group Guiding Questions

1.	Among the users of Uber, what percentage use Uberpool?
2.	What is the cost of an average Uberpool trip compared to the standard UberX trip?
3.	Does Uberpool trip cost less, even if there is no other pooler?
4.	How does the Uber surge pricing affect the cost of Uberpool trips?
5.	What is the profile of those who choose to use Uberpool?
6.	Which areas in London do people tend to travel using the Uberpool and UberX services the most?
7.	On a typical shift, how many trips are Uberpool trips compared to standard UberX trips?
8.	When is the demand for Uberpool trips at the highest point (i.e., days & times etc.)?
9.	Do drivers always have to accept an Uberpool request? Moreover, what are the consequences for drivers if they reject an Uberpool trip?
10.	How many times can a driver reject an Uberpool request; before he/she is frozen out and is there a maximum quota?
11.	What types of trips/journeys are being made using Uberpool?
12.	Have passengers commented on what transport option they were using before Uber?
13.	Who do you think is the main competitor? Public transport, walk, cycle or taxi?
14.	Why do you think people choose to use Uberpool compared to UberX?
15.	How do local/regional Transport Authorities currently deal with Uber operations? Are there any guidelines or limitations provided?
16.	How are drivers' rights protected or regulated?
17.	Has there been any issue arising from Uberpool operations since its launch?
18.	Do you have any views on how Uber is impacting conventional Public Transport?
19.	What element of Uberpool works well and what does not work so well?
20.	Do you think Uberpool has impacted walking & cycling trips? If yes, how? (i.e., are fewer people walking or cycling due to Uberpool?)

The composition of the different focus group participants is shown in Figure 4, which shows that focus group session one had more younger (age 26-30) and older (age 46-50) drivers, compared to focus groups two and three, while focus group three had no representation for 26-30 age group. The participants' length of service with Uber varied, with an average of 2.9 years for focus group one, 1.9 years for focus group two and 2.6 years for focus group three. Although feedback during the focus group sessions indicated that there are a few female Uber drivers in London, there is no available data on Uber driver gender demographics and the local transport agency has no ridesourcing specific data. At a national level in 2018, 4% of licenced drivers (i.e., Taxi, Private Hire, and licenced Chauffeurs) in England were female (DfT, 2018), which includes any female Uber drivers. Although, several attempts were made to recruit female participants including, speaking directly with a female driver, and making contact through Uber driver social media groups, none ultimately took part. Accordingly, all the focus group participants were male.

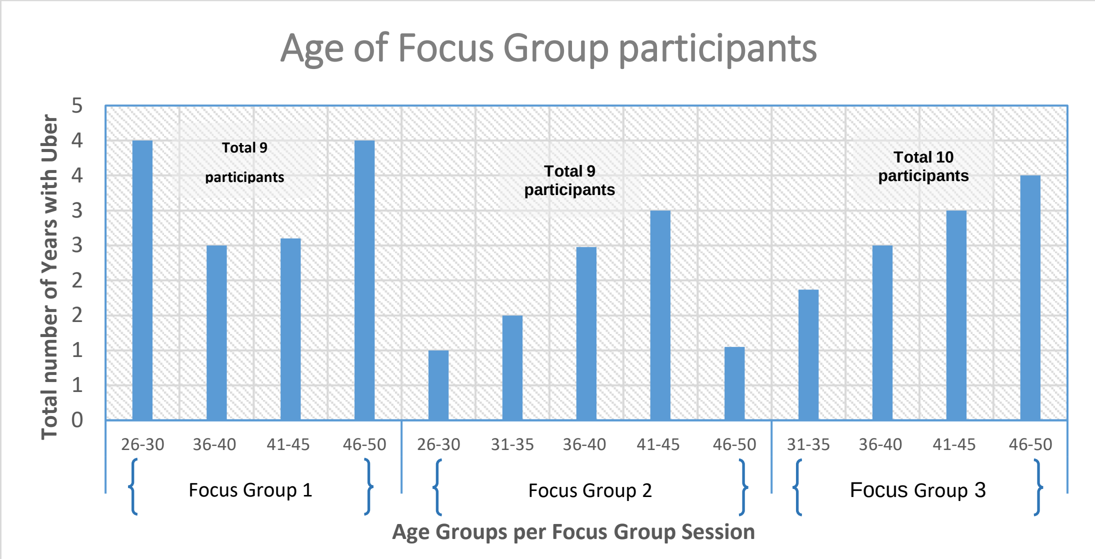

Figure 4: Composition of Uber Driver Focus Group participants

3.2.3 Survey

Using surveys is a popular method for data collection in quantitative research, and with the use of ICT, availability of survey software and social media platforms, it is reasonably easy to reach a large number of participants. For this study, Uber users completed a self-completed intercept survey in London. Surveys of this kind will help us understand existing conditions at a given time to ascribe an order of magnitude to various transport phenomena and help to establish causal explanations of conditions at a given time so that greater understanding can be obtained (Richardson, et al., 1995). One of the most common data collection methods in transport studies involves the use of surveys for both RP and SP data collection. However, surveys are not without limitations as noted by Bryman (2008) participants could understand the survey questions differently. Therefore, different participants may respond differently, based on their understanding and the consistency of participant's stated and actual behaviours, which could be different. Accordingly, extra care needs to be taken when designing and administering surveys for research data collection.

A quantitative approach was adopted for this research, using a survey questionnaire as the data collection method. Quantitative methods are used in empirical research on transport, depending on the objectives of the study (Moser & Kalton, 2017). The survey questionnaire approach for data collection was deemed the most suitable method to obtain adequate data from UberX and Uberpool users. It included questions on demographics, reasons for mode choice, cost of service, trip purpose, origin-destination, and effects on car ownership, as detailed in Table 6.

There are various sampling techniques used to determine what an appropriate size should be for a study of this nature. A survey sample should reflect the wider population and thus be representative of the study population, in the case of this study the population of Greater London. Because of how the Uber user survey was designed and the method and process of data collection, a nonprobability sampling method using a convenience sampling technique was used. This is typically adopted when participants are selected based on certain attributes, such as being a user of a specific service like Uber. This method is dependent on the availability of the participants and being able to access the survey while in the process of that activity. Hence why Uber users were provided with the survey forms during their Uber trip. However, this approach provides no control over how representative the collected data is. Unfortunately, it was not possible to precisely verify the representativeness of the collected Uber user surveys, mainly for two reasons. Firstly, there was no available data on Uber or any ridesourcing services in London to check against and TfL (at the time of the survey) did not collect any data about Uber (or any ridesourcing) usage. Secondly, the London Travel Demand Survey did not capture sociodemographic profiles for each mode and shared ridesourcing services such as Uberpool were generally grouped with taxi and private hire mode data. This study's survey data was essentially the first known independent data collected from Uber users in London.

Another important aspect of quantitative methods is determining the sample size of the survey; in this case, how many Uber users to survey. Usually, the larger sample sizes yield more reliable results. However, it is not always possible to obtain a large sample size because of time, cost, and resource constraints. Deciding on the minimum sample size for this study was not easy, mainly because there were no previous data collected from Uber users in similar cities or using the same methods to compare. Also, no known best practice sampling guidelines were found for this type of survey due to the novelty of the study. It was also expected that Uberpool survey responses might take longer or be difficult to achieve since approximately 15 to 20 per cent of all daily Uber trips were Uberpool. Therefore, relevant previous research was reviewed, and the most relevant studies were found to have conducted surveys ranging from 300 to 2000 depending on the objectives of the study. Accordingly, it was deemed reasonable to aim for 1000 surveys with the aim of achieving a 60 to 70 per cent survey response rate.

Table 6. Summary of Survey Questionnaire

1. What is the purpose of your trip, today?	2. For what type of trip/journey do you normally use UberX/Uberpool?
3. Where did your UberX/Uberpool trip start today?	4. How many other Uberpool users have shared the vehicle with you today on this trip? *(Only applies to Uberpool survey)*
5. How much do you agree with the below statement? *I have no problem if the driver diverts to pick-up/drop-off another passenger along the same route.*	6. When did you start using UberX/Uberpool?
7. How often do you use UberX/Uberpool during the following times?	8. Which of the following do you use the most to get around London?
9. What is the estimated cost of your UberX/Uberpool trip today?	10. On average how much do you save per trip by using Uberpool instead of normal UberX? *(Only applies to Uberpool survey)*
11. Why did you use UberX/Uberpool today instead of Public Transport options such as Tube, Train and Bus?	12. If this is not your first time using UberX/Uberpool, how often do you use the service?
13. How many times have you used any Uber service in the last month?	14. If UberX/Uberpool were not available, what other transport mode would you most likely use for this same trip?
15. What transport option (mode) did you use the MOST for the same journeys before you started using UberX/Uberpool	16. Would you still use UberX/Uberpool, if you had better access to public transport options (e.g., Bus, Train, Tram, and Tube)?
17. How would you rate the UberX/Uberpool service?	18. Why did you use UberX/Uberpool today instead of Walking or Cycling?
19. What are the reasons for using Uberpool compared to standard UberX or Taxi service (e.g., minicab/black cab)? *(Only applies to Uberpool survey)*	20. What are the reasons for using UberX compared to standard Uberpool or Taxi service *(only applies to UberX survey)*
21. Do you have a driver's license?	22. Do you currently own a car?
23. Did you own a car before start use of UberX/Uberpool services?	24. Do you own an Oyster / Travel card to use for public transport?
25. How much effect does UberX/Uberpool, or similar services have on your need to own a Car?	26. Are you a Visitor or Resident of London?
27. What is your employment status?	28. What is your age group?
29. What is your gender?	30. What is your highest level of education completed?

Pilot investigations are commonly conducted for empirical research. Pilot investigations are a practice run or testing-out of aspects of the research, which is then used to inform the final study (Baker, 1994). As part of the survey questionnaire development process, a pilot survey was conducted with nine different UberX and Uberpool users in order to get feedback about the survey questionnaire and assess how best to administer the survey.

The questionnaire forms for the two Uber services were separated following feedback during the pilot surveys and the final survey questionnaire for UberX and Uberpool were developed. The final surveys took approximately 4 minutes to complete each survey and provided simple tick box options for each question while mostly limiting open-ended questions. A sample of the survey forms can be found in Appendix B.

A total of 1000 survey forms (500 UberX and 500 Uberpool) were printed, each on a double-sided A4 size survey card (1 page per survey) for distribution. To reach Uber users during their Uber trip so they can complete the survey, nine London Uber drivers were recruited. The nine drivers indicated their willingness to each take a set of survey forms and provide the surveys to any willing passengers at the start of the trip.

The drivers were initially part of three focus group sessions held with the 28 London Uber drivers. The recruited drivers were from different parts of London, primarily South, East, and West, and usually started their shift from their local area. All nine Uber drivers worked full time for Uber and served both UberX and Uberpool customers across the Greater London area and worked varied shift arrangements that included some hours during the day and some at night throughout the week, with the occasional day(s) off.

Each driver was provided with a set of UberX and Uberpool surveys, a clipboard and an introductory letter explaining about the survey and contact details of the researcher in case passengers requested the information. Before commencing the Uber user survey, each driver was given basic training and briefing sessions, that they should ask the passengers to complete the surveys voluntarily and what they should do if the passenger had queries or refused. For Uberpool services, if there were two or more poolers (i.e., those who booked separate Uberpool trips), the drivers provided the survey forms to all the passengers who were happy to complete the surveys and for UberX the surveys forms were given to the primary traveller. The Uber users were provided with an opportunity to opt-in (i.e., leaving their contact information at the end of the survey form) for a raffle draw as an incentive for completing the survey. The raffle draw took place at the end of the survey data collection and three lucky winners each received one of £50 amazon gift vouchers.

The surveys were conducted from the first week of January 2018 to the end of April 2018 and covered all Greater London area. As a follow-up, meetings were held with each of the nine drivers once a week (in the first six weeks) and later once every fortnight to collect completed survey forms, discuss feedback and deal with any issues that arose during that time. After sifting, there were 907 (450 UberX and 457 Uberpool) successfully completed surveys forms received. Subsequently, the collected data were entered into an excel database, cleaned, and prepared for statistical analysis. The socio-demographic profiles of the survey participants are shown in Table 7.

Table 7. Socio-demographic profiles of UberX and Uberpool users in London

	Uberpool		UberX	
Employment Status.	Qty.	%	Qty.	%
• I am a student	67	15%	69	16%
• I am employed/self employed	349	77%	346	79%
• I am retired	12	3%	5	1%
• I am unemployed	23	5%	16	4%
Age group.				
• 18 to 25	71	16%	98	22%
• 26 to 30	92	20%	102	23%
• 31 to 35	71	16%	102	23%
• 36 to 40	77	17%	58	13%
• 41 to 45	47	10%	38	9%
• 46 to 50	54	12%	28	6%
• 51 to 55	26	6%	16	4%
• 56 or over	15	3%	5	1%
Gender.				
• Female	227	50%	223	50%
• Male	226	49%	225	50%
• Other	4	1%	0	0%
Highest level of education completed.				
• College	113	25%	92	21%
• None	4	1%	8	2%
• Postgraduate	128	28%	141	32%
• Primary School	13	3%	3	1%
• Secondary School	31	7%	22	5%
• Undergraduate	167	37%	178	40%

3.3 Data Analysis Methodology

The data collected was analysed using different techniques and software tools in order to obtain meaningful information. This section of the methodology Chapter describes the different data analysis techniques used for this research and the tools employed to analyse the qualitative and quantitative data.

3.3.1 Qualitative Data Analysis

Qualitative data analysis is inductive, meaning that conclusions are based on observation of a limited number of specific cases/events/behaviours and entails a process of coding in which data are broken down into small units (called codes) and deciding which codes are grouped to form categories that are used to create key themes (Merriam & Tisdell, 2016; Corbin & Strauss, 2015). Coding the qualitative data is an iterative process of seeking meaningful patterns in text content and involves an initial breakdown of raw text into categories. These categories are discrete and detail a phenomenon (e.g., based on each research question), which are inductively connected to form a higher order, more abstract concept, called a theme. Themes emerge by systematically linking categories to context, action/interaction strategies, and consequences. The analysis intents to find a common core of consensual meanings across categories; therefore, the criteria for a credible analysis in that it is plausible, cohesive, and correspondence with the data is demonstrable (Denzin & Lincoln, 2013).

For this study, there are two sets of qualitative data. Interview data were collected from transport policymakers, operators, innovators, industry experts, and ridesourcing service providers. Furthermore, focus group data were collected from London Uber drivers. These methods were used to draw the experiences and viewpoints of the interviewees and focus group participants.

Interview and focus group data can be analysed in several ways, including manual content analysis (coding and theme development manually) or thematic content analysis using tools like SPSS (Statistical Package for the Social Sciences) or NVIVO. Conducting analysis using software tools such as NVIVO provides several advantages over doing it manually. These software tools help to organise the data more efficiently (Welsh, 2002) and provide more accurate and thorough coding and interpretation of the data while reducing processing time and allowing for better management of the data and the analysis (Eboli & Mazzulla, 2007). Moreover, NVIVO helps with the process of searching and investigating links between the different themes. Qualitative data analysis requires providing for any subjective bias (which might enter in the case of manual analysis) and using the software tools can reduce such problems.

Furthermore, qualitative analysis software has been successfully employed by researchers in transport studies. For example, Carr (2008) used software to analyse data collected from interviews in a case-study based research to assess employee interest in public transport for commuting to work. In addition, Simons et al. (2013) used SPSS to analyse the data from focus groups in research to understand participants' motivations for using various transport modes.

A thematic approach was utilised for this study to analyse and find meaningful themes across the qualitative data and the analysis of the qualitative data conformed to a multi-stage process as recommended by (Creswell, 2007). This comprised data transcription, development of themes using codes and data representation. The themes correlated with the guiding questions used for the interviews and focus groups, which sought to find insights and data about the use of shared and non-shared ridesourcing services and its relationship with PT.

Accordingly, the collected interview and focus group data were verbatim transcribed solely by the researcher using Microsoft Word and then analysed using NVIVO 11 to seek meaningful patterns and emergent themes that are relevant and helpful in answering the research questions. The qualitative data analyses in NVIVO 11 included extensive content analysis, including initial coding to create the coding structure and then review and reading of each transcript to verify and edit codes where applicable. This software was chosen because it is designed to help researchers organize, analyse, and find insights in unstructured or qualitative data such as interviews (QSR International, 2017). NVIVO is useful in qualitative data analysis because it can help improve the rigour of the analysis process by validating (or not) some of the researcher's own impressions of the data and because it is designed to carry out administrative tasks of organising the data more efficiently (Welsh, 2002).

After analysing all the qualitative data, a process of reviewing and verifying the results was done for each dataset and the findings were presented in coding impressions. The results for the qualitative data analysis are presented in Chapters Five and Six of this Thesis.

3.3.2 Quantitative Data Analysis

For this study, the quantitative data was collected from UberX and Uberpool Users in London, using an intercept survey approach. The survey data was initially analysed using descriptive analysis and cross-tabulation techniques, then later statistically modelled using a Categorical Regression method. Full details of the quantitative data analysis are presented in the subsequent sub-sections.

Descriptive Analysis

The quantitative Uber user survey data was initially analysed using descriptive analysis and cross-tabulation techniques to summarise data in a meaningful way, obtain basic information about all variables and explore patterns and relationships between different variables. Statistical Package for the Social Sciences (SPSS) was used for accomplishing the descriptive statistical analysis. Accordingly, descriptive statistics were produced, along with cross-tabulation and chi-square tests to understand relationships between different categorical variables and the two different Uber services (UberX and Uberpool). Statistical significance tests were performed and the correlations variations between different variable groups were examined. According to Bryman (2008), the chi-square test is a non-parametric, bi-variate test that makes use of two nominal variables for checking statistical significance.

Dahiru (2008), clarifies that the P-value is the probability under the assumption of no effect or no difference (i.e., null hypothesis) of obtaining a result equal to or more extreme than the observed. It measures the likelihood that any observed difference between test groups is by chance. The closer the P-value is to zero, the greater the unlikelihood that the observed difference is by chance. P-values are generally influenced by sample size and the spread of the data. The statistical test results were considered significant if the P-value was below 5% ($P < 0.05$).

Descriptive analyses were conducted for all variables and more detailed cross-tabulation and chi-square tests were performed for key variables. For all the variables, the percentages, and quantities of responses (frequencies) were reported. Moreover, to compare the data between UberX and Uberpool users, either a Chi-square difference or a one-way analysis of variance (ANOVA) were performed to test for significant differences. The chi-square difference test is commonly used in research to examine whether there are significant differences between observed frequencies in one or more categorical variables. In contrast, one-way ANOVA tests are used to determine whether there are significant differences between the means of two or more independent groups. For the study, the chi-square test was used for the categorical variables (i.e., variables with no true mean), whilst the one-way ANOVA test was used for the numerical and scale variables. For both tests, the P-values were examined to determine whether the differences between groups were significant or not.

After using a chi-square test to find the significance of 2 groups, for example, ‘Service Type’ and ‘Age Group’ and a chi-square test has found the difference to be significant, a column proportions test was used to compare pairs of columns, testing if the proportion of answers in one column was significantly different from the proportion in the other column. This is used to see which rows and columns are responsible for the relationship and if the relationship has been found to be significant by the chi-square test. In addition, if the outcome variable was continuous, such as ‘Cost’, or ‘Frequency of use in the last month’, an independent t-test was used to test the significance and compare two groups against these variables. During data analysis, the datasets from two Uberpool drivers were selected randomly for validation purposes and the resulting data were examined for discrepancies.

Statistical Modelling Using Categorical Regression (CATREG)

After completing the descriptive analysis, a set of statistical models were developed to find a deeper understanding of the factors that affect the use of Uberpool services and the reasons for using the services. The models were developed in SPSS and the Categorical Regression (CATREG) approach was adopted as the most suitable method.

CATREG quantifies categorical data by assigning numerical values to each category, thereby achieving an optimal linear regression equation for the transformed variables. The CATREG approach allows simultaneously scaling of nominal, ordinal, or numerical variables. Moreover, this technique allows the optimal scaling level to be set for the variables (dependent and independent) and measures categorical variables, so the quantifications reflect attributes of the initial categories and provide the quantifications output when the regression is run. Furthermore, the model calculates a standardized coefficient for the predictor (independent) variables, revealing how changes in the predictor variables influence the responses (IBM Knowledge Centre, 2021).

CATREG generates the relative importance of the predictor variables using Pratt’s measure of importance, which clarifies predictor (independent) variables’ contribution. The predictor variables with high importance values denote the level of importance to the model. This method also generates the transformation plots that indicate the quantifications for each variable. Accordingly, these aspects of the CATREG model output help explain the degree of influence by the predictor variables.

For this research, four main CATREG models were developed to investigate and find a greater understanding of the key factors that affect how Uberpool services are used and reasons for use. Some of the main CATREG models (i.e., models two and three) had several sub-models depending on the number of categories that the dependent variables had. From the descriptive analysis results, the core independent and dependent variables were identified, which were then later used for statistical modelling using the CATREG function within SPSS. The dependent and independent (i.e., factors) variables shown in Table 8 were used for the CATREG modelling and were primarily based on the survey questions.

Table 8: The dependent" and "independent" variables used in the different CATREG models

Dependent Variable	**Independent Variables** *(Factors that may affect the dependent variable)*	
Model 1: The factors that affect the frequency of using Uberpool services. The responses for this variable were categorised into four groups as follows: *I.* **At least once daily** *(a combination of "2x or > daily" & "1> daily")* II. **At least once weekly** *(a combination of "once or twice weekly" & "2-4 times weekly")* III. **At least once a month** *(a combination of "less than once a week" & "1-2 times a month")* IV. **Rarely** *(a combination of "less than once a week" & "1-2 times a month")* Note: The independent variables were tested one by one to see if they have influence in the model. Subsequently any non-significant independent variables were removed from the model.	**<u>Socio-demographics</u>** 1. Age group (Q27) 2. Gender (Q28) 3. Employment status (Q26) 4. Education level (Q29) **<u>Trip characteristics</u>** 5. Trip purpose (Q1) 6. Trip origin (Q3) 7. Trip cost (Q9) 8. Trip cost saving compared to UberX (Q10) 9. When trips are made (Q7A_Night) 10. When trips are made (Q7C&D_Weekdays) 11. When trips are made (Q7B&E_Wkends&P/Holidays)	**<u>User perception about the service</u>** 12. User perception of how fast the services are compared to PT modes (Q11B) 13. User perceived safety compared to PT modes (Q11C) 14. User perception of sharing a ride with stranger (Q5) 15. User rating of service (Q17) **<u>Access to alternative modes.</u>** 16. Car owner at present (Q21) 17. Holding driving licence (Q20) 18. Oyster (travel card) owner (Q23)

<table>
<tr>
<td>Model 2: The factors that affect passengers' decision to use Uberpool instead of Public Transport modes.

Three models were developed for the below dependent variable categories. each dependent variable had possible outcome of agree, disagree or neutral.
1. Cheaper
2. Door to Door service
3. There is no PT stop/station near my origin/destination

The rest of the outcomes were omitted from this model as there was not enough variation in the data.</td>
<td><u>Socio-demographics</u>
1. Age group (Q27)
2. Gender (Q28)
3. Employment status (Q26)
4. Education level (Q29)
<u>Trip characteristics</u>
5. Trip purpose (Q1)
6. Trip origin (Q3)
7. Trip cost (Q9)
8. When trips are made (Q7A_Night)
9. When trips are made (Q7C&D_Weekdays)
10. When trips are made (Q7B&E_Wkends&P/Holi days)</td>
<td><u>User perception about the service</u>
11. User perception of how fast the services are compared to PT modes (Q11B)
12. User perceived safety compared to PT modes (Q11C)
13. User perception of sharing a ride with stranger (Q5)?
14. User rating of service (Q17)
<u>Access to alternative modes.</u>
15. Car owner at present (Q21)
16. Holding driving licence (Q20)
17. Oyster (travel card) owner (Q23)</td>
</tr>
<tr>
<td>Model 3: The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi.

This dependent variable was recoded based on the 7 possible responses and binary digits of 1 or 0 were used for ease of modelling. (See example).
<u>Sample recode table</u>
<table>
<tr><th>ID</th><th>Cheaper</th><th>Quicker</th><th>Want to meet people during trip</th><th>Safer</th><th>More environmentally friendly</th><th>Want to help reduce traffic</th></tr>
<tr><td>P1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>P2</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>P3</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
</table></td>
<td><u>Socio-demographics</u>
1. Age group (Q27)
2. Gender (Q28)
3. Employment status (Q26)
4. Education level (Q29)
<u>Trip characteristics</u>
5. Trip Cost (Q9)
6. Trip cost saving compared to UberX (Q10)
7. Trip purpose (Q1)
8. Trip origin (Q3)
9. When trips are made (Q7A_Night)</td>
<td>10. When trips are made (Q7C&D_Weekdays)
11. When trips are made (Q7B&E_Wkends&P/Holi days)
12. Number of times using the service in the last month (Q13)
<u>User perception about the service</u>
13. User perception of sharing a ride with stranger (Q5)
14. User rating of the Uberpool service (Q17)
<u>Access to alternative modes.</u>
15. Car owner at present (Q21)
16. Holding driving licence (Q20)
17. Oyster/travel card holder (Q23)</td>
</tr>
<tr>
<td>Model 4: The Transport modes that Uberpool services are replacing.

The responses for this variable were categorised into four groups as follows:
I. Use PT (a combination of "use PT bus" & "use the tube, train or tram")
II. Use active travel options (a combination of "Walk" & "Cycle")</td>
<td><u>Socio-demographics</u>
1. Age group (Q27)
2. Gender (Q28)
3. Employment status (Q26)
4. Education level (Q29)
<u>Trip characteristics</u>
5. Trip Cost (Q9)
6. Trip purpose (Q1)
7. Trip origin (Q3)
8. When trips are made (Q7A_Night)</td>
<td><u>User perception about the service</u>
12. User perceived safety compared to PT modes (Q11C)
13. User perceived safety compared to W&C (Q18B)
14. User perception of how fast the service is compared to PT modes (Q11B)</td>
</tr>
</table>

III. **Use a car as a passenger** *(a combination of "get a lift from family/friend" & "use a taxi")* IV. **Drive a car alone** The response categories of 'use a car-club', 'did not make this trip' and 'other' were omitted from this model as there was not enough data for these categories.	9. When trips are made (Q7C&D_Weekdays) 10. When trips are made (Q7B&E_Wkends+P/Holidays) 11. Aim of meeting other people during trip (trip socialising) (Q19 answers only for "*I want to meet people during trip*")	15. User perception of how fast the service is compared to W&C (Q18A) 16. User perception of ease of requesting and paying via app compared to other modes (Q11F) 17. User rating of service (Q17) 18. User perceived comfort of the services compared to PT modes(Q11D) 19. User perceived comfort of the services compared to W&C (Q18C) **<u>Access to alternative modes.</u>** 20. Oyster/travel card holder (Q23) 21. Holding driving licence (Q20) 22. Car ownership (present) (Q21)

A total of ten CATREG models were accomplished as detailed in Tables 9, 10, 11 and 12. An iterative process was followed to reach the optimal model output. Furthermore, a total of 22 different factors were tested to find the most important factors that affect the use of Uberpool services and reasons for usage. The following elements were considered for each CATREG model to determine the final optimal model for each dependent variable.

- The goodness of fit (R squared values)
- The beta values
- Significance (P-value)
- The Pratt's importance value
- Quantification values and plots

Table 9 shows all independent variables (factors) and the primary dependent variable used in CATREG Model 1 and the response categories for each variable. The independent variables were tested one by one to see if they have influence in the model in terms of significance, importance and effect on the beta and goodness of fit test of the model. Subsequently any non-significant independent variable(s) were omitted from the model.

Table 9: CATREG Model 1: Variables used to model 'The factors that affect the frequency of using Uberpool services'.

Dependent Variable		
The factors that affect the frequency of using Uberpool services		**Response options**
		1. **At least once daily** *(a combination of "2x or > daily" & "1> daily")*
		2. **At least once weekly** *(a combination of "once or twice weekly" & "2-4 times weekly")*
		3. **At least once a month** *(a combination of "less than once a week" & "1-2 times a month")*
		4. **Rarely** *(a combination of "less than once a week" & "1-2 times a month")*
Independent Variables		
Factor Group	**Factors tested in Model 1**	**Response option(s) for each factor**
Socio-demographics	Age group	*{18 to 25}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}*
	Gender	*{Male}, {Female}*
	Employment status	*{Student}, {Employed / Self Employed}, {Retired}, {Unemployed}*
	Education level	*{Postgraduate}, {Undergraduate}, {College}, {Secondary School}, {Primary School}, {None}*
Trip characteristics	Trip purpose	*{Home}, {Work or School/College/Uni}, {PT Station/stop Shopping/Family errands/visiting/other}, {Social event/activity}, {Airport}*
	Trip origin	*{Airport}, {Home}, {Social event/activity (i.e., gym, bar etc.)}, {Family or friends place}, {Office/workplace}, {Public Transport station/stop}, {Other}*
	Trip cost	*{Written by respondent}*
	Average fare saving compared to UberX	*{Less than 4%}, {5% to 10%}, {11% to 20%}, {21% to 30%}, {More than 35%}, {I don't use UberX / I Don't know}*
	When trips are made (Night)	*{Frequent}, {Infrequent}*
	When trips are made (Weekdays)	*{Frequent}, {Infrequent}*
	When trips are made (Weekends & P/Holidays)	*{Frequent}, {Infrequent}*
User perception about the service	Perceived quickness of services compared to PT modes	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User perceived safety compared to PT modes	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User perception of sharing a ride with stranger	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User rating of service	*{Excellent}, {Average}, {Poor}*
Access to alternati ve	Car owner at present	*{Yes}, {No}*
	Holding driving licence	*{Yes}, {No}*
	Oyster (travel card) owner	*{Yes}, {No}*

Table 10 below details all independent variables (factors) and the main dependent variable that were used in CATREG model 2 and the response categories for each variable. CATREG model 2 had three sub-models because the dependent variable had three different options, as follows:

1. CATREG Model 2A – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, 'because it is cheaper'
2. CATREG Model 2B – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, 'because it is a door-to-door Service'
3. CATREG Model 2C – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, 'because there is no PT stop/station near my origin/destination'

The independent variables were tested one by one or in combinations to test if they have influence in the model in terms of significance, importance and how much they affect the beta values and goodness of fit test of the model. Subsequently, any non-significant independent variable(s) were omitted from the models.

Table 10: CATREG Models (2A, 2B and 2C). Variables used to model 'the factors that affect passengers' decision to use Uberpool instead of public transport modes'.

<table>
<tr><th colspan="3">Dependent Variable</th></tr>
<tr><td colspan="2" rowspan="4">The factors that affect passengers' decision to use Uberpool instead of Public Transport modes:
a) 'Because it is Cheaper'
b) 'Because it is a door-to-door Service' or
c) 'Because there is no PT stop/station near my origin/destination'</td><td>Response options</td></tr>
<tr><td>1. Agree</td></tr>
<tr><td>2. Disagree</td></tr>
<tr><td>3. Neutral/Undecided</td></tr>
<tr><th colspan="3">Independent Variables</th></tr>
<tr><th>Factor Group</th><th>Factors tested in CATREG Models 2A/2B/2C</th><th>Response option(s) for each factor</th></tr>
<tr><td rowspan="4">Socio-demographics</td><td>Age group</td><td>{18 to 25}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}</td></tr>
<tr><td>Gender</td><td>{Male}, {Female}</td></tr>
<tr><td>Employment status</td><td>{Student}, {Employed / Self Employed}, {Retired}, {Unemployed}</td></tr>
<tr><td>Education level</td><td>{Postgraduate}, {Undergraduate}, {College}, {Secondary School}, {Primary School}, {None}</td></tr>
<tr><td rowspan="2">Trip characteristics</td><td>Trip purpose</td><td>{Home}, {Work or School/College/Uni}, {PT Station/stop Shopping/Family errands/visiting/other}, {Social event/activity}, {Airport}</td></tr>
<tr><td>Trip origin</td><td>{Airport}, {Home}, {Social event/activity (i.e., gym, bar etc.)}, {Family or friends place}, {Office/workplace}, {Public Transport station/stop}, {Other}</td></tr>
</table>

	Trip cost	*{Written by respondent}*
	When trips are made (Night)	*{Frequent}, {Infrequent}*
	When trips are made (Weekdays)	*{Frequent}, {Infrequent}*
	When trips are made (Weekends & P/Holidays)	*{Frequent}, {Infrequent}*
User perception about the service	Perceived quickness of services compared to PT modes	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User perceived safety compared to PT modes	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User perception of sharing a ride with stranger	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User rating of service	*{Excellent}, {Average}, {Poor}*
Access to alternative modes.	Car owner at present	*{Yes}, {No}*
	Holding driving licence	*{Yes}, {No}*
	Oyster (travel card) owner	*{Yes}, {No}*

Table 11 details all independent variables (factors) and the main dependent variable that were used in CATREG Model 3A, 3B, 3C, 3D, and 3E and the response options for each variable.

CATREG model 3 had five models because the dependent variable had six different categories, as detailed below. One of the categories (the 6th category) for the dependent variable was not modelled because there was not enough variation in the response data for that category.

1. CATREG Model 3A – The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is quicker'.
2. CATREG Model 3B – The factors that affect passengers' decision to use Uberpool instead of Public Transport Modes, 'because I want to meet people during trip'.
3. CATREG Model 3C – The factors that affect passengers' decision to use Uberpool instead of Public Transport Modes, 'because it is safer'.
4. CATREG Model 3D – The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is more environmentally friendly'.
5. CATREG Model 3E – The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because I want to help reduce traffic congestion'.

The independent variables were tested one by one or in combinations to assess whether they have influence in the models in terms of significance, importance and any effect in the beta values and goodness of fit test of the model. Subsequently, any non-significant independent variables were excluded from the models.

Table 11: CATREG Model 3. Variables used to model 'the factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi'.

Dependent Variable		
The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi (Q19).		**Response options**
		1. Yes
		2. No
Independent Variables		
Factor Group	**Factors tested in CATREG Models 3A, 3B, 3C, 3D, & 3E.**	**Response option(s) for each factor**
Socio-demographics	Age group	*{18 to 25}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}*
	Gender	*{Male}, {Female}*
	Employment status	*{Student}, {Employed / Self Employed}, {Retired}, {Unemployed}*
	Education level	*{Postgraduate}, {Undergraduate}, {College}, {Secondary School}, {Primary School}, {None}*
Trip characteristics	Trip purpose	*{Home}, {Work or School/College/Uni}, {PT Station/stop Shopping/Family errands/visiting/other}, {Social event/activity}, {Airport}*
	Trip origin	*{Airport}, {Home}, {Social event/activity (i.e., gym, bar etc.)}, {Family or friends place}, {Office/workplace}, {Public Transport station/stop}, {Other}*
	Trip cost	*{Written by respondent}*
	Average fare Saving Compared to UberX Service	*{Less than 4%}, {5% to 10%}, {11% to 20%}, {21% to 30%}, {More than 35%}, {I don't use UberX / I Don't know}*
	When trips are made (Night)	*{Frequent}, {Infrequent}*
	When trips are made (Weekdays)	*{Frequent}, {Infrequent}*
	When trips are made (Weekends & P/Holidays)	*{Frequent}, {Infrequent}*
	Number of times using the service in the last month	*{Written by respondent}*
User perception about the	User perception of sharing a ride with stranger	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User rating of service	*{Excellent}, {Average}, {Poor}*
Access to alternative modes.	Car owner at present (Q21)	*{Yes}, {No}*
	Holding driving licence (Q20)	*{Yes}, {No}*
	Oyster (travel card) owner (Q23)	*{Yes}, {No}*

Table 12 shows all independent variables (factors) and the primary dependent variable that was used in CATREG Model 4, in addition to the response categories for each variable. This CATREG model assesses the key factors that influence whether Uberpool services substitute for other tradition transport modes.

The independent variables were tested individually or in groups to test whether they have any significant influence in the model in terms of significance, importance and effect in the beta values and goodness of fit test of the model. Subsequently, any non-significant independent variables (factors) were omitted from the model.

Table 12: CATREG Model 4. Variables used to model the transport modes that Uberpool services are replacing

Dependent Variable		
Transport mode used the most for the same/similar trip before Uberpool.		**Response options**
		1. Use PT
		2. Use Active Travel options
		3. Use Car as Passenger
		4. Drive Car alone
Independent Variables		
Factor Group	**Factors tested in CATREG Model 4**	**Response option(s) for each factor**
Socio-demographics	Age group	*{18 to 25}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}, {26 to 30}*
	Gender	*{Male}, {Female}*
	Employment status	*{Student}, {Employed / Self Employed}, {Retired}, {Unemployed}*
	Education level	*{Postgraduate}, {Undergraduate}, {College}, {Secondary School}, {Primary School}, {None}*
Trip characteristics	Trip purpose	*{Home}, {Work or School/College/Uni}, {PT Station/stop Shopping/Family errands/visiting/other}, {Social event/activity}, {Airport}*
	Trip origin	*{Airport}, {Home}, {Social event/activity (i.e., gym, bar etc.)}, {Family or friends place}, {Office/workplace}, {Public Transport station/stop}, {Other}*
	Trip cost	*{Written by respondent}*
	When trips are made (Night)	*{Frequent}, {Infrequent}*
	When trips are made (Weekdays)	*{Frequent}, {Infrequent}*
	When trips are made (Weekends & P/Holidays)	*{Frequent}, {Infrequent}*
	Reason for using Uberpool instead of UberX or traditional taxi _ Because "I want to meet people during trip"	*{Yes}, {No}*
User perception about the service	User perceived safety compared to PT	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User perceived safety compared to Walking & Cycling	*{Agree}, {Disagree}, {Neutral/Undecided}*
	Perceived quickness of services compared to PT modes	*{Agree}, {Disagree}, {Neutral/Undecided}*
	Perceived quickness of services compared to walking & Cycling	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User perception of ease of requesting and paying via app compared to other modes	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User rating of service	*{Excellent}, {Average}, {Poor}*

	User perceived comfort of the services compared to PT modes	*{Agree}, {Disagree}, {Neutral/Undecided}*
	User perceived comfort of the services compared to Walking & Cycling	*{Agree}, {Disagree}, {Neutral/Undecided}*
Access to alternat	Car owner at present	*{Yes}, {No}*
	Holding driving licence	*{Yes}, {No}*
	Oyster (travel card) owner	*{Yes}, {No}*

3.4 Selection of Case Study City

The study area for this research is the Greater London area, primarily due to the availability of extensive transport options and the transport policy and operations setup. Uber services in London were selected as a case study for this study because London provides a comprehensive case to understand the implications of shared and non-shared ridesourcing services on traditional PT modes and transport policymaking in a UK City. London has a single transport authority, Transport for London, a well-integrated public transport system and experiences traffic congestion and emissions from road transport. Additionally, Uber is the largest ridesourcing operator in the Greater London area and the UK in general.

Furthermore, London has one of the most developed urban public transport networks in Europe (TfL, 2016), which includes all PT modes, cycle hire schemes, black cabs, private hire and taxi services, car clubs and ridesourcing services. Both Uberpool and UberX are available in London, and Uber has seen one of the most significant growth areas in terms of registered Uber drivers and number of trips. Moreover, London has an ambitious transport strategy with targets to reach 80% PT and active travel mode share by 2041 (GLA, 2018). Therefore, considering its transport and urban characteristics, London was considered an excellent case study for understanding the use of ridesourcing services such as Uber, including the reasons why travellers have adopted these new services instead of other modes of transport that are available in London and the consequences for policymaking and London's traditional PT modes.

3.5 Ethical considerations

For this study, all necessary ethical requirements were met by the researcher and approval was taken from the relevant university research ethics representative. In addition, prior to contacting participants and collecting data, a consent form was developed and information about the research and the need to obtain their consent was shared with all interviewees and focus group participants. For the surveys, the consent statement was printed on all the survey forms and provided to each person completing the survey. All the interviewees and focus group participants provided written consent (signed form or email). This process helped all those who participated in the research to understand the purpose of the research, the processes that were being followed and provided acknowledgement of their willingness to take part and give permission for the use of the data and information for the research. All data used in the research has been anonymised before processing, so there are no direct references to any individual participants.

Accordingly, the data collection and analysis for this study were conducted in full compliance with the University's research ethical guidelines.

3.6 Chapter Summary

This chapter presented the methods that were adopted for collecting and analysing data for this study. In addition, details about data collection and analysis approaches that are generally used in transport studies are discussed.

A mixed method approach that consisted of quantitative and qualitative data was used to answer the research questions. The quantitative data for this study were collected using a questionnaire, while the qualitative data was collected using a combination of interviews and focus groups. As such, the different methods used, and the processes followed are explained. The qualitative data consisted of interviews with 31 different transport policymakers, transport operators, innovators, industry experts, ridesourcing service providers, and 28 focus group participants (Uber drivers). The survey data yielded a total of 907 responses from Uberpool and UberX users in London.

Furthermore, details are provided about the different data analysis and modelling techniques used for the qualitative and quantitative data, including the different CATREG models that were developed, and tools used to analyse and model the different data. The quantitative data were initially analysed using descriptive analysis and cross-tabulation techniques to summarise data in a meaningful way, get basic information about all variables. Subsequently, the primary dependent and independent variables were identified and then a total of ten CATREG models were completed to gain a thorough understanding of the factors that affect the use of Uberpool services in London.

Additionally, the rationale for selecting London for this study and how the research ethics were addressed are discussed.

The next chapter will provide details about London's public transport policy and operations and the reasons why London makes a good case study are discussed.

Chapter 4: Case study: London public transport policy and operations

4.1 Introduction

London, UK, was selected as the case study city for this research. London is the capital of the UK and ranks high as one of the most outward-looking and innovative, international cities globally. It is a very diverse and well-connected city, making it one of the most desirable places to work and live (Marsden & May, 2006). Transport services are important since they connect communities, generate new opportunities, and create the conditions for the city to thrive (Marsden & May, 2006; Hickman, et al., 2011; Stone & Aravopoulou, 2018). Transport services also shape Londoners' daily lives by determining how much physical activity they do and the length and enjoyability of their daily journeys around the city (GLA, 2018). London was considered an excellent case study for investigating the use of shared and non-shared ridesourcing services and its relationship with PT. There are comprehensive PT modes, taxi, and private hire services available in the city. Therefore, understanding why ridesourcing has been widely used and its implication on traditional PT modes are important.

This chapter presents an overview of the different PT services available in the case study city and summarises the current PT policy structure in London and the operational setup of the city's PT services. In addition, it explains how the different PT modes are managed and the core similarities and differences with other large cities, thereby highlighting why London makes an excellent case study for investigating use of shared and non-shared ridesourcing services and its relationship with PT.

4.2 Overview of Transport Services in London

London has an extensive and well-integrated urban transport system that includes bus, the Tube, tram, Docklands Light Rail (DLR), taxi and private hire services, bike share and a road network that extends across 33 boroughs (includes City of London) in Greater London. The London bus network operates a 24-hour service and covers the entire Greater London area (TfL, 2021b; Visit London, 2020a). Historically, London had an extensive bus network that was affordable and provided good coverage across the city (LTM, 2020; TfL, 2021a). Currently, the city's modern double-decker buses are the cheapest way to travel around London, providing good coverage and opportunity for sightseeing during the journey. Moreover, all of London's buses are cashless, and travellers can use the Oyster card or contactless payment method. The bus fare in London is set at a maximum of £1.50 regardless of trip length and most bus routes operate daily, including a night service (TfL, 2021a; Visit London, 2020a). Although bus ridership has been declining in recent years, there were 2.5 million trips made on London buses in 2017/2018 (TfL, 2020b). Tram services in London operate in South London (i.e., Wimbledon and Croydon) and run concurrently with the bus services (Visit London, 2020c). The use of London trams grew in the first 15 years of operation (from 2001) but has declined since. In 2019/20, demand for trams was down by close to 5.3% in the journeys covered compared to 2018/19 (TfL, 2020c), although ridership has been declining on both bus and tram services, these modes provide easy accessibility mobility service in London especially in areas with limited or no access to the Tube network.

London's most prominent PT service is the London underground rail network, commonly known as 'the Tube'. Opened in 1863, the Tube is one of the oldest and largest in the world (Greenham, et al., 2020). The Tube network comprises 11 Tube lines with 270 stations (Greenham, et al., 2020; TfL, 2021b). The Tube operates between 5 am and midnight, from Monday to Saturdays, with some reduced services on Sundays.

Several Tube lines operate 24-hours and cost for a single adult journey via zone one starts from £2.90 (peak time) when using an Oyster card or contactless payment, and £4.90 when using a single journey ticket. Furthermore, TfL operates the London Overground rail services on six routes across the city (TfL, 2021b). Besides the Tube and London overground services, there is also a commuter rail network that connects London to the edges of Greater London and beyond, for example, Chiltern Railways, Greater Anglia, and Thameslink (Visit London, 2020d).

On average, the Tube carries over 1.3 billion passengers each year and Waterloo station is one of the busiest, with an estimated 100 million passengers annually (TfL, 2021e). As such, the Tube is considered a critical feature of London's transport system.

Another transport mode available in London is the public cycle hire scheme, making it convenient for travellers to access cycle hire services across the city and use the extensive cycling network. The cycle hire scheme was launched in 2010 by the mayor of London, having been inspired by a similar scheme in Paris, France (Lathia, et al., 2012;

BBC, 2020). The cycle hire scheme has over 750 docking stations and nearly 11,500 bikes for hire. Access to one of the bikes (also referred to as Santander bikes) costs approximately £2 for 24 hours. However, each trip's first 30 minutes are complimentary, and trips that are more than 30mins long will cost another £2 (TfL, 2020a). The cycle hire scheme is available to travellers daily throughout the year. The travellers can use a bank/credit card or other forms of contactless payment to avail the service (Lathia, et al., 2012; Visit London, 2020b; TfL, 2021b). During 2019/2020, there were over 590,000 monthly cycle hire trips in London, with Waterloo station being the highest in demand (over 42,000 trips started there in a single quarter). The London cycle hire scheme has seen over 93 million rides since its launch and is generally seen as a successful service (TfL, 2020a; BBC, 2020).

London has several for-hire transport services including the iconic black cabs and the private hire minicabs. The black cabs date back to 1650s and included the development of the Fellowship of Master Hackney Coachmen (Butcher, 2018; Skok & Baker, 2019; Skok & Tissut, 2003). Because of the regulations governing how black cabs are operated, they are the only for-hire services that passengers can flag down on the street or at designated ranks without prior booking. Moreover, they benefit from the use of specifically designated ranks commonly in popular places, such as the mainline rail, bus, and Tube stations (Butcher, 2018; Skok & Tissut, 2003). The Black cab services are always metered and have a minimum fare of £3.20 plus a per-mile fare that depends on the time of travel (TfL, 2021c). However, conventional private hire minicabs can be a cheaper alternative since they do not operate on a meter. The regulatory system for black cabs and private hire minicabs differs. The quality of the black cab drivers, fares, and the standards of vehicles used to provide the services are highly regulated (TfL, 2021d; Skok & Tissut, 2003). However, the number of taxis in operation is not limited and as of March 2020, there were 115,000 licensed vehicles in London, of which 19,000 were black cabs, which was a 5.8% decrease compared to the previous year. In contrast, private hire vehicles increased by 8.9% during the same period (DfT, 2020).

The latest form of for-hire services in London is ridesourcing services such as Uber. Ridesourcing allows user to book a private hire trip using a smartphone application that links travellers with ridesourcing drivers (London Assembly, 2018; Uber, 2021). Uber began operations in London in 2012 with the standard UberX service, which was permitted by TfL (Dudley, et al., 2017; Skok & Baker, 2019). Uber is cited as the primary contributor to a remarkable increase in the number of licensed private hire vehicles operating in London, which increased from 49,854 in March 2013 to an estimated 84,886 in November 2016 (London Assembly, 2018). Initially, Uber service were characterised by the Uber smartphone app's novelty and its ability to undercut the fares of traditional private hire services by using the principles of the 'sharing economy' (Dudley, et al., 2017; Skok & Baker, 2019). The ridesourcing business model allowed the drivers to supply their vehicles and experience flexibility in terms of the number of hours worked. Uber estimates the number of private hire drivers who use the Uber app to make money is over 45,000 where the average driver makes close to £11 per hour after deducting the Uber commission and more than 3.5 million travellers in London are registered regular users in London (Uber, 2019). However, several high-profile regulatory disputes exist between Uber and TfL (Mohamed, et al., 2019).

Efficient mobility supports economic growth, and this is no different in London, where transport services enable businesses to reduce costs by moving people and goods more quickly, easily, and reliably (Wingham, 2017; Vickerman, 2018). Consequently, this helps businesses to grow and be competitive. Mobility services also help people get to/from work quickly thereby creating access to job opportunities as well as more flexible labour market conditions and more inward investment, making London a great place to live and do business (DfT, 2013; Wingham, 2017). Accordingly, efficient transport services have direct benefits to people, businesses, the environment, and the general economy.

Some of the other essential features of London's transport system include:

- Automatic vehicle location systems and on-board passenger information and announcement systems
- Journey planner that includes all PT modes
- Real-time information on bus arrival timings at bus stops, online and via an app
- Real-time taxi booking systems
- Intermodal and electronic fare collection system including contactless payment technology
- Dedicated lanes for buses and cyclist, with traffic signal priority for buses and bus lane enforcement systems

- Personal rapid transit (PRT) system at London Heathrow Airport.
- Network coordinated traffic signal system (SCOOT based) and variable speed limit control system
- Digital traffic enforcement cameras (red light and speed)
- The congestion charging system, which uses automatic number plate recognition (ANPR)
- Ultra-Low Emission Zones
- Extensive electric vehicle charging infrastructure
- Transport Oriented Developments (TOD) and Parking management systems

4.3 Public Transport Policy Structure in London

In England, the Department of Transport is the government body responsible for transport policy. However, the Greater London Authority (GLA) and the Mayor of London set the regional policy agenda for Greater London area, which is then delivered through Transport for London (TfL) as the regulator and ultimate transport authority in London. The GLA was established in 2000 due to the ratification of the 1999 Greater London Authority Act (Marsden & May, 2006; Rode, 2019). The GLA is led by an elected mayor and 25 directly elected assembly members. Moreover, TfL serves as the decision-making and regulatory body of the mayor and works in conjunction with the GLA to ensure the city's transport needs are met (Marsden & May, 2006; Rode, 2019; Le Vine & Polak, 2019).

TfL manages all the primary PT services in London such as the London Underground, bus services, river services, tram, and light rail and the London Overground while regulating the other transport modes such as taxi, private hire services, ridesourcing and cycle hire. Moreover, TfL manages about 580km of main roads in Greater London and all the traffic light and traffic management assets (including congestion charging). TfL also oversees or is responsible for other critical London-wide functions such as planning, economic development programs, and environment protection (Marsden & May, 2006; Le Vine & Polak, 2019).

London's primary transport policy document is the Mayor's Transport Strategy, which sets out the most important priorities, strategies, and actions for transport in London (GLA, 2018). Although TfL plays an extensive role, the 33 London boroughs also play a part in policy implementation at the borough level. The boroughs consult with the Mayor and TfL on borough level 'local plans' which should be aligned with the London Plan and the Mayor's Transport Strategy (GLA, 2018; GLA, 2021). The mayor of London works closely with the DfT to ensure that the government invests in the city's transport network. The Crossrail Project is an example of this collaboration. TfL also relies on network rail and other rail companies to link London to the rest of the country.

One of the key policy objectives in the mayor's transport strategy focuses on developing healthy streets, which includes reducing car dependency and increasing active, efficient, and sustainable travel within London (GLA, 2018). Although there has been some progress in encouraging travellers in London to switch from car use to modes that include active travel and more efficient, sustainable options, the city continues to experience traffic congestion and related pollution problems. According to the TfL, approximately 25% of current car trips could be walked, while 67% could potentially be cycled. As such, the Mayor's Transport Strategy sets out an ambitious target of 80% of trips to be made on foot, by cycle, or through public transport by 2041 (GLA, 2018). However, achieving these targets largely depends on various external factors such as how streets are planned, particularly accessible and conducive infrastructure for walking, cycling and PT use. The advent of new transport services such as Uber is a policy challenge that needs addressing, and there are no clear policy measures and or regulations for new mobility services such as ridesourcing to ensure they are beneficial for all Londoners (GLA, 2018).

PT bus ridership in Greater London has been declining in recent years, and it is not clear the real cause of this, but the availability of more and more mobility options is noted as a possible reason (Martin, 2019; Loxton, et al., 2019). Travellers in London can move around the city using private cars, ridesourcing services, cycle hire services and various PT options, including the Tube, which now operates 24-hour services in some lines. Moreover, the low fuel prices and the ease of accessibility and affordability of minicab taxi services and the various ridesourcing services have also been blamed for contributing to this decline in bus usage (Martin, 2019; Loxton, et al., 2019). Furthermore, the increasing number of cars on London's roads, irrespective of whether they are private vehicles or used to provide ridesourcing services, naturally increases congestion, slowing bus travel times. London's traffic congestion rose by close to 14%

between 2010 and 2016 (Loxton, et al., 2019). The availability of more environmentally friendly modes, such as cycling, may have also contributed to the decline in PT bus usage (Leeder, 2018). For instance, the number of cycling trips in London increased by nearly 30% between 2010 and 2017 (Loxton, et al., 2019). Public bus services are an essential transport mode for London and other urban and suburban areas since buses can help ease congestion problems and provide access to mass transport to those from low-income or rural communities while being an important mode for people with disabilities (Martin, 2019; Loxton, et al., 2019). To mitigate the decline, in 2017 the mayor allocated a minimum of £20 million annually for bus priority measures and traffic signal timings to improve bus travel times. In addition, TfL has developed plans to reduce under-used bus services and re-allocate them to high demand areas. To make bus travel more affordable and convenient, TfL introduced the 'Hopper' bus fare which allowed travellers to switch buses at no extra cost within one hour of starting their trip (Martin, 2017; Martin, 2019; Leeder, 2018). The decline in bus ridership needs further investigation in collaboration with the bus operators since it will have a long-term impact on fare revenues.

Generally, London's transport policy and operational setup are considered an exemplary model due to TfL's success in creating an integrated transport authority, which is acknowledged as a leading urban transport agency (Marsden & Docherty, 2019). In London, TfL advocates for the use of smart ticketing, making the transport system easy to use and ensuring that different PT modes work together to provide end-to-end mobility for travellers. For example, the introduction of the Oyster card in 2007, which was enhanced over the years with other cashless payment methods (Baigabulova, 2010; Marsden & May, 2006). Other global cities are facing similar regulatory and operational challenges to London, for example, Tokyo and Taiwan where Uber still operates notwithstanding major obstacles (Watanabe, et al., 2017), therefore it is crucial that transport authorities such as TfL develop guidelines and pertinent regulations to manage the rapid growth of ridesourcing services.

4.4 Public Transport Operations in London

There is an extensive public transport operational system in London with TfL as the ultimate transport authority, which controls the strategic road network and all major PT modes whilst regulating all other public accessed transport services. However, The London boroughs are responsible for 95% of London's Road network. TfL operates the

London Underground (i.e., the Tube), the London Overground, The DLR and the Tram and River services (TfL, 2021b). Moreover, London's PT bus services are operated by private sector operators based on contracts, which TfL specifies, the routes, timetables, and fares, while also providing the required infrastructure (Paulley, et al., 2006; Marsden & May, 2006). Private sector operators compete for the opportunity to operate bus services based on tenders issued by TfL. This is one difference compared to other parts of the UK, for example in West Yorkshire and Edinburgh where private sector companies operate bus services granted the duty to decide on routes, fares, and timetables (Marsden & May, 2006). London's PT bus service's operational structure is considered better than other regions in the UK such as West Yorkshire and Edinburgh because it enforces a certain level of flexibility that keeps the fares below inflation and encourages PT bus usage as part of TfL's social objective.

Mayor of London, through TfL also has the authority to implement congestion charging schemes across the Greater London area, without initiating a public inquiry (Marsden & May, 2006; Lulham, 2011; Skok & Baker, 2018), however, TfL cannot overrule the parking policies within designated areas that fall under the local boroughs. Although TfL can restructure how road space is used within the strategic road network that is controlled by TfL, the London boroughs decide what happens within their respective boundaries, subject to their local priorities for accessibility and parking (Marsden & May, 2006; Lulham, 2011). Accordingly, this is different to other regions outside London such as West Yorkshire where the responsibility remains with the metropolitan district authorities in the lower tiers and Edinburgh, where the city of Edinburgh council has total control over all the demand management aspects, including controls over parking and pricing, charges on congestion, and reallocation of road spaces (Marsden & May, 2006).

New transport options, such as ridesourcing, have caused various operational challenges in London since specific regulations that govern such services do not exist. Currently, all ridesourcing services such as Uberpool are considered a form of private hire service and TfL licences the services under the Private Hire Vehicles (London) Act 1998 (Skok & Baker, 2019; Dudley, et al., 2017). These regulations were enacted before the idea of booking a for-hire services using a smartphone app was envisioned. Accordingly, TfL faces challenges placing ridesourcing services into the current private hire and taxi operational system (Skok & Baker, 2018), without updating or developing specific regulations that address some of the issues brought about by companies such as Uber.

4.5 Private Hire and Taxi Services

In London, Transport for London (TfL) regulates the London private hire vehicle and taxi sector in Greater London and is tasked with delivering the mayor's transport strategy. The UK private hire and taxi market was estimated to grow 1.1% annually and was expected to reach £ 9.9 billion by 2022 (Skok & Baker, 2018; EC, 2016). The private hire vehicle services (also referred to as 'minicabs') provide a pre-book vehicle service for passengers (Pepić, 2018). Moreover, the black taxi is also used for travel by way of hailing on the streets (Smart & Wang, 2020). The present London tax regulations (London Hackney Carriage Act) and the private hire vehicles regulations (the Private Hire Vehicles (London) Act) were passed before the concept of ridesourcing where services are requested, and payment is made via a smartphone application.

Private hire operators, drivers and vehicles in London are licensed under the Private Hire Vehicles Act 1998, while black cabs are regulated using various acts depending on which different aspects such as the fares, drivers, and vehicles. These regulations range from the London Hackney Carriage Act 1831, the Metropolitan Carriage Act 1869, through to the London Cab Act 1968 (TfL, 2013; Marique & Marique, 2018). Differences between private hire (i.e., minicabs) and black cab services emanate from operational restrictions. For instance, private hire operators must comply with several technical conditions set, including record-keeping of bookings and drivers' details, procedures for handling complaints and policies on lost and found property (TfL, 2021d; Uber, 2019). The cost of a private hire vehicle license depends on the number of vehicles operated and lasts for five years. Upon receiving their license, private hire drivers must be pre-booked through their operator and cannot be flagged down on the street without a booking. They also cannot use taxi ranks or bus lanes and are now required to pay the congestion charge if they enter the zone.

Moreover, the drivers cannot use taximeters and must provide an approximate fare before starting the trip (TfL, 2021d). However, to get a black cab licence, drivers need to pass 'the knowledge', a special test developed for black cab drivers that comprises of seven stages and usually takes several years to complete. The vehicles also must comply with special requirements and design features that make them fit to be a taxi (i.e., wheelchair accessibility, ventilation, taxi signs), have a taximeter, and include a facility to accept card and contactless payment. Black cabs are permitted to use taxi ranks and bus lanes, and they can be flagged down on the street without any prior booking. In addition, black cab fares are calculated automatically and visible to the passenger on taximeters approved by TfL and fitted by approved installers (TfL, 2020c; TfL, 2021d).

The COVID-19 pandemic has resulted in the enforcement of additional measures to safeguard passengers and drivers in all private hire, black cab, and ridesourcing services. Travellers are required to use a face covering, use hand sanitisers, and wash hands before and after travelling. Moreover, TfL requires all Black cab, minicab and ridesourcing companies and drivers to establish protective measures to protect passengers. For instance, all operators must ensure that drivers wear face coverings while offering any type of for-hire service (GLA, 2021b; TfL, 2020c).

4.6 Uber Services in London

Uber first launched its operations in London in 2012, after Hailo (now called MyTaxi), a smartphone booking application had launched a year earlier (Skok & Baker, 2019; Marique & Marique, 2018). Various types of services are offered through the Uber smartphone app, including the UberX service, which is the basic (low cost) option for single trips and may include a 4-seater car, such as Toyota Prius in addition to Uber Exec, Uber XL, Uber Assist, Uber Access, Uber Lux and Uberpool (Mohamed, et al., 2020; Uber, 2021). Uber Exec caters for premium rides in high-end cars, while Uber XL provides affordable rides for groups up to 6 passengers (reduced to maximum five pax during COVID-19), while Uber Lux customers enjoy ultimate luxury and style with high-end vehicles. Furthermore, The Uber Assist and Uber Access services cater to travellers that require special assistance from trained drivers and those that require wheelchair accessible services (Uber, 2021). Uber also provides a shared option, Uberpool, which started in London in 2015 after holding broad discussions with TfL and agreeing to follow their requirements. It allows each traveller to pay reduced fare compared to other Uber services because poolers share the cost of travel (Mohamed, et al., 2020; Uber, 2021).

The Uber platform allows individuals (i.e., drivers) to use their car – which could be owned or rented – to offer ridesourcing services to others for a fee. Through a smartphone app, customers can request a ride, get the driver and vehicle identification details, and track its location with Geographic Information Systems (GIS) and global positioning systems (GPS). Once the ride is complete, the app processes the payment automatically. At the end of each trip, the customer can rate the driver, and the driver can also rate the passenger (Mohamed, et al., 2019).

Some of Uber's main successes in the UK relate to its rapidly growing ridership in London. Uber did not bring per se technological innovation in London but played a major role in the expansion of private hire digital platforms in the city. Uber did this by developing a specific algorithm for matching travellers with available drivers and offering the option to pool trips, thereby providing a cheaper taxi type service to its users (Mohamed, et al., 2020).

Even though Uber's entry into the London market sought to abide by set regulations, its popularity resulted in disapproval in various ways. Recently, debates, criticisms, and judicial challenges have arisen concerning Uber operations in the city. Key issues related to the licensing process, compliance, license renewal, and data issues (Marique & Marique, 2018). The peak of Uber's issues came in 2017 when TfL decided not to renew its operating license for London services. A court case and extensive discussions concerning the impact of ridesourcing services on London's transport network followed this. Uber received a temporary license to continue operations in London in mid-2018, but policymakers and regulators are yet to clarify how these services will be regulated and managed in the future (Mohamed, et al., 2019). There is no publicly available data on Uber's impact in London; however, Uber services could contribute to increased congestion and issues relating to labour, which require further investigation and possible regulation.

Globally similar ridesourcing issues have arisen, for example (Rayle, et al., 2016) found increased congestion and labour issues brought about by Uber in San Francisco. Moreover, California passed a bill that could have compelled the ridesourcing companies to classify its drivers as employees (University of Pennsylvania, 2019; Spicer, et al., 2018). However, Uber remained defiant, maintaining its classification as a technology platform company which allows independent drivers to use its smartphone app to operate in the city. On similar grounds, Uber was fined $649 million in New Jersey in 2019 for claiming that their drivers were not employees (Haag & McGeehan, 2019; Spicer, et al., 2018). Policymakers and transport regulators continue to struggle to deal with ridesourcing companies or manage these new services as part of the traditional transport modes. These issues will only increase as more ridesourcing providers emerge. For example, in London, besides Uber, several companies have all started to offer various types of ridesourcing services, including Addison Lee, Bolt, Kapten and Viavan. On one hand, the availability of new ridesourcing options might be a good thing for travellers; however, ridesourcing poses a significant challenge for traditional PT modes if more travellers decide to switch from the primary PT modes such as buses and trains. Moreover, the adoption of ridesourcing could increase the number of cars on the road and thus worsen congestion in the city and cause delays for PT buses whilst increasing emissions and worsening driver labour issues.

In London, the issue has been increased by several key events, including the increasing number of new shared ridesourcing service providers (i.e., Via) and two court cases between Uber and TfL, in 2017 and 2019 relating to the non-renewal of Uber's London operating license. Uber continued to operate until the court cases were concluded and eventually were re-issued the operating licence. Also, a supreme court case involving Uber and former Uber drivers has recently resulted in a ruling that all Uber drivers shall be considered employees and not independent contractors. The controversy surrounding Uber operations in London highlights the need for adequate data on ridesourcing usage to support the development of suitable policy measures and regulations for ridesourcing services.

4.7 Summary

This chapter presented details about public transport services that are available in London. Moreover, it highlighted how PT operations and policymaking are managed and the role of the various mobility options thereby outlining why London is a suitable case study for investigating the usages and implications of ridesourcing services such as Uberpool and its relationship with traditional PT services.

London has a well-integrated and comprehensive PT system that includes bus, the Tube, London Overground, water transport, the Tram and DLR services, Cycle hire, Black cabs, minicabs and ridesourcing services. Transport plays a key role in making London a global capital. For example, according to TfL, the Tube network carries over 1.3 billion passengers annually, which is the highest across all the available modes. However, the iconic black cabs have been decreasing in number, as ridership of minicabs and ridesourcing services increased. Uber is the largest ridesourcing service provider in London, with various options offered via the Uber app such as the UberX and Uberpool services.

TfL is the ultimate transport authority in London, which operates mass transport modes such as the Tube and regulates all for-hire services, such as black cabs and all types of private hire services including Uber. Through TfL, the Mayor of London sets the city's transport strategy and coordinates with the 33 London boroughs and DfT to realise London's transport objectives. The mayor's current transport strategy focuses on reducing car dependency and increasing active and sustainable travel. However, PT bus ridership in Greater London has been declining in recent years and the causes for this are not known.

Moreover, TfL manages the city's strategic road network while the boroughs are responsible for all local road network. Uber started services in the city in 2012 with UberX service, and in 2015 launched the Uberpool (shared) service. These new ridesourcing services have resulted in regulatory and operational challenges, although they have generally been popular with users. There are no specific regulations dealing with ridesourcing and the services are licenced under the private hire vehicle regulations, which were developed for traditional minicab services. Additionally, ridesourcing data is not collected by TfL, so it is uncertain how these new services are affecting traditional PT modes.

As more ridesourcing services emerge, policymakers and transport regulators in London need to address the operational, regulatory and policy challenges posed by ridesourcing and look at how shared services such as Uberpool can supplement main PT services or help to fill gaps in the PT network.

Therefore, London provides an excellent case study to understanding shared (Uberpool) and non-shared (UberX) ridesourcing services in a European or UK city context. It is important to obtain data that explains why ridesourcing is used, by who and for what trip purposes in London, considering the wide-ranging network of PT options that are available in the city.

The next chapter will provide results from the interviews with transport policymakers, operators, experts, and service providers in London.

Chapter 5: Interviews results

5.1 Introduction

The first set of qualitative data for this research were collected from 31 participants from transport authorities and policymakers, PT operators, industry experts and innovators, and ridesourcing service providers using a semi-structured interview format. The list of interview questions, data analysis methods, in addition to the socio-demographic profiles of the interviewees and the organisations they represented, are detailed in Chapter Three of this thesis.

The aim was to find insights and data on whether transport authorities, policymakers, PT operators in London understood the impact of ridesourcing services, including shared ridesourcing and how they were dealing with it. Also, to identify key challenges and opportunities emerging from Uberpool services and fully capture all participants' viewpoints to answer research question three. The interviewees were asked a set of research questions that covered the effects of Uber services, including data collection and monitoring, the operational implications, and the role of ridesourcing services in the future transport system.

After analysing the interview data, three themes emerged. Accordingly, the results were organised into three dominant themes, each with related sub-theme(s) for ease of interpretation and obtaining meaningful outcomes to answer the research questions. The three main themes were the effects of shared and non-shared ridesourcing services; the operations of ridesourcing services; and the role of ridesourcing services in the future. Each theme had several sub-themes, as shown in the following sections.

This chapter presents the findings from the interviews data analysis, including the implications of Uber services (including Uberpool) on transport policymaking, regulations, and the wider effects on traditional modes of PT and congestion in the city.

5.2 Interviews with policymakers, PT operators, and other stakeholders

The interview data were anonymised per the research ethics, and all interviewees were assigned an identification code, which included the letter [P] followed by a number and one of three letters [i.e., A = policymakers, regulators, and transport authorities; O = PT operators; I = Industry experts/researchers/innovators and R = Ridesourcing service providers] to indicate whom the interviewee represented. So, for example, [P5/O] means interview participant number five, representing PT operators.

The results for the three themes are offered in the subsequent sections.

5.2.1 Theme 1: The Effects of Shared and non-Shared Ridesourcing Services

An important element of this research was investigating the effects that ridesourcing services were having on congestion and traditional PT services. In addition, to examining if transport authorities, PT operators and policymakers undertook monitoring or data collection activities to inform how these new mobility services should be managed or regulated and understand the broader consequences from shared and non-shared ridesourcing services. The interviewees were asked several questions to obtain adequate feedback and viewpoints.

Monitoring the impact of ridesourcing services on PT modes and congestion in London

The interviewees were asked, "If there was any data available that showed the impact of Uber on congestion and traditional PT in London since the services were launched", to examine how much was known about ridesourcing services in general and understand if there was any data that explained the true impact of ridesourcing services (i.e., all Uber services) on congestion and PT modes in the city. The results revealed that the transport authorities and policymakers in London did not have any Uber service usage or impact data, and there were no arrangements in place to collect any data from Uber or other ridesourcing service providers. The only information that policymakers had were about the number of PHV licences issued in London. However, there was no distinction between minicab services and ridesourcing services such as Uber.

The only available information regarding Uberpool, and its potential impacts were from media or other public information. The interviewees explained,

"We don't collect that sort of data…" (P3/A).

"… we recently did some counts and was not Uber specific, it was for private hire vehicles. The problem we had was, historically, you couldn't identify the PHVs, but now you have the licence disk in the back, but it is still too much work for one surveyor because they have to classify all the vehicles and look at the cars and identify them. So, for a long time, we didn't know how many there were on the street. We knew how many are licenced because we are the licencing authority…" (P6/A).

"…the short answer is no, we have various means of collecting transport-related data, so we have things like STATS19 and the NTS (National Transport Survey), so we do have means of collecting data, but I don't think it is detailed enough for us to be able to say because of Uber congestion has increased this much and we can confidently say that there is a cause or relationship between the introduction of Uber and whatever else…" (P7/A).

"No, I’m not aware of anything that’s actually tried to quantify and say what congestion Uber causes, to sort of say how much extra congestion do they causes, I know Uber doesn’t say themselves, they claim in London certainly that they don’t cause that greater congestion. The time that most Uber cars are on the road, they say, are not the sort of peak times necessarily for congestion on London’s roads, so they claim they are not generators of great congestion. But I don’t know of any analysis that’s been done, that could officially quantify this one way or the other..." (P1/I).

Furthermore, the interviewees were also asked: "if there were any existing mechanisms to monitor the impact of Uberpool and (if not) if there were any plans to develop regular data collection and monitoring systems". The results indicate that there are currently no mechanisms in place in London to monitor the impacts of services like Uberpool or ridesourcing in general. None of the policymakers, transport authorities or operators interviewed had short-term plans to undertake any monitoring of ridesourcing services. Accordingly, the specific effects of ridesourcing services are still unknown and unquantified due to the absence of empirical data. The responses included,

> "…I think, at the moment, we don't have a mechanism to monitor the impact of these things…, I do not think what we have at the moment is sophisticated enough to do that. In terms of what we are doing for the future, I actually don't feel we have anything in place at the moment that is going to answer those questions for us in the future…" (P7/A).

> "No, I'm not aware of any, really and not really aware of any plans either…" (P13/O).

> "… I think the real problem is, Uber is not ready to share the data. It is very difficult for the authorities to monitor it without having access to the data. So, the authorities need to make a better regulation…" (P12/I).

> "There isn't at the moment, there's nothing there. I've talked to so many people and nobody has got anything to try and monitor or plans to develop one…" (P15/I).

The understanding about Uber services and perceived effects

To explore the views and understanding of key stakeholders, for example, the transport authorities, PT operators and policymakers about ridesourcing services in London and gather important perspectives about Uber in general and particularly Uberpool, the interviewees were asked what their views were about "Uber services in general and if Uber has been a positive or negative addition to the city's transport system". The results showed that interviewees broadly considered Uber a positive addition to the city's transport network, particularly for the customers who benefited from its flexibility, lower cost, and ease of access. There were hopes that disruption from ridesourcing services could help inspire new improvements and innovations in the traditional PT sector, however, there were doubts about its effect on congestion and PT ridership. The interviewees said,

> "…you can certainly say a positive impact in terms of the technological advance and the convenience it gives to people. I mean, obviously, people can use the app to book and to process the payments and so on. I think it certainly facilitates it and makes it

a lot easier to have that access, you know to a car, almost instant access so to speak, that you can book a ride and have easy access to it. I think it is certainly an asset to a city`s transport system. I don’t think you can say it is detrimental to it, but of course, obviously, there are other factors involved. Of course, when we talk about the impacts on general city traffic and other operators…" (P11/I).

"I think it has been a useful and positive development because, if nothing else, it has done two things. It has generated publicity for public transport and whilst there has been some adverse publicity. I think, generally, it has been good publicity because it just heightens peoples' awareness of what is out there and what the alternatives are to car travel and I think it is also acting as a stimulus to other companies who are already in the local operating market to think more about what they do, what services they offer, how they deliver those services, how they can better interact with people and grow demand for public transport more generally…" (P16/O).

"I think they have disrupted the transport system. They have disrupted the traditional models of the transport system. They have raised a lot of questions. They have openly been very aggressive. They are certainly a contributing factor to congestion within Central London, and that congestion is caused simply by the number of vehicles that want to access this space not being equal to the amount of space there is. It is not to say it's not been good in some ways. Giving more people access to transport is always a good thing, but it's obviously difficult to – it's a very fine balance, and I don't think it's quite right" (P9/A).

"…from the social benefit point of view, I think Uber has been positive because it has added choice, flexibility, and affordability for many users who can't access black cabs and don't want to use PT. I think from a social point of view, Uber's been a bit of a revelation and been very positive from that view. It clearly had a negative impact on congestion in Central London with the tens of thousands of drivers and vehicles on the road at any one time. So, there needs to be a balance struck, and the balance isn't quite right yet…" (P21/O).

Moreover, when asked about their "views and understanding of Uberpool and its impact", the interviewees explained that the concept of Uberpool is well understood in general, and pooling (sharing) of trips was considered a positive aspect of ridesourcing services. It has the potential to help reduce single-occupancy car or taxi trips and complement PT services in some instances. However, the lack of data about the service remains a major obstacle to fully understanding Uberpool. The interviewees asserted,

> "… if you are going to take three vehicles off because you got a fourth vehicle that's got the driver and three or four occupants in it, rather than four different journeys – that's got to be a good thing. Now it's not necessarily a good thing for Uber or Uber drivers, but it's a good thing for the environment, it's a good thing for congestion, it's a good thing for sustainability in a whole raft of ways. So that Uber pooling has got to be better than standard UberX…" (P14/A).

> "…we definitely don't have any data or anything on Uberpool. The concept is sensible. Obviously, it is pooling journeys. I think in TfL, there are certain safeguarding concerns around any form of ride pooling, but we understand that there are also key benefits. It's probably better than an Uber that carries one person. I'll say an Uberpool carrying two people that wouldn't have otherwise shared a journey is better than an Uber carrying one person, but a bus carrying 40 people is probably better still if that makes sense…" (P9/A).

> "… it's very early to make that judgment because it's not clear to us what consumers think about the service and in particular if they have a choice between using an Uberpool and an existing bus service what their decision points are about how they choose between those two things and at the moment, we haven't got any clear evidence…" (P8/A).

> "I think that could be more of a complement to public buses and so, on and so forth, so I don't have any view that it would harm our industry more. All solutions that can increase sharing is good. So, overall, I believe it would be a complementary service which is a good thing for everybody..." (P24/R).

Moreover, in order to explore the main issues and challenges of shared ridesourcing services in London, the interviewees were asked if there has been "any issues arising from Uberpool operations since it launched in London". The findings showed that most interviewees said that there were no major issues that they were aware of. However, transport authorities and policymakers indicated they had concerns about passenger safety, mainly due to apprehension following media reports about assaults on passengers and other negative media coverage of Uberpool usage. The interviewees said,

"… I think in terms of operations it seems has gone smoothly…" (P5/I).

"No, there might be some things in the media…" (P15/I).

"Across the millions of trips that have taken place, there might have been one or two safety incidents, because Uber is very popular at night, so there may have been, couple youngsters, who have had too much to drink, that have got disorderly at the back, I don't know, but if you Google Uberpool stories, there may be one or two things that come up. There have been no major issues…" (P4/R).

A quick Google searched revealed various newspaper reports, including several incidents between Uberpool passengers. However, there were also some articles by Uber regarding how the service works and positive quotes from customer feedback, including someone who met their partner in an Uberpool trip.

"Not in relation to the bus industry. I am aware of some of their battles over things like the conditions under which their drivers have engaged and whether they are employees or not and whether they are entitled to the various benefits…" (P8/A).

Moreover, some of the transport authority and policymaker interviewees explained that,

"We have concerns, but we are not aware of any incidents where people's safety has been compromised by the use of Uberpool" (P3/A).

> "The safety and security risk has merit. There are some driver concerns. There is not the same level of driver controls as we have on black cab drivers who have undergone 'the knowledge' and have gone through a lot of driver training. It is not quite the same in the private hire sphere in general, and so I think that there are probably some concerns" (P9/A).

These safety concerns contrasted with the views from drivers during the focus group sessions who reported high levels of customer satisfaction due to having the ability to monitor the entire Uber trip, know details of the vehicle, driver, and journey route via the Uber app, which can be shared with friends or relatives if needed. However, there is still the question of who is responsible when there is an issue between two Uberpool passengers, which is an issue the drivers are struggling with since there are no clear guidelines from the regulators or Uber. This was also raised by one of the policymaker interviewees, who stated,

> "I think probably the biggest thing is safety. It has to be safety. If you're possibly a lone woman maybe in a car, then the driver almost becomes the person responsible for making sure that they arbitrate between passengers who are arguing or if someone does something inappropriate to a woman…" (P18/A).

The issue of safety has been further exacerbated by the very high-profile decision taken in 2017 by TfL to reject the renewal of Uber's London operating license, with passenger safety, reporting serious criminal offences by drivers and how medical certificates were obtained being cited as some of the numerous concerns highlighted by TfL (TfL, 2017). Although Uber has since been granted its operating licence, the several court cases between Uber and TfL concerning compulsory English tests for drivers and introducing congestion levies on Uber services entering the central London congestion charge area. Moreover, a recent case between Uber and Uber drivers resulted in a UK supreme court ruling, which ruled that Uber drivers shall be considered employees and therefore shall be entitled to employee benefits (BBC, 2021). These cases all provided highly politicised media coverage (mainly negative) and amplified the debate about Uber operations and the perceived impacts it is having in London.

5.2.2 Theme 2: The Operations of Ridesourcing Services

The interviewees were asked several questions relating to shared and non-shared Uber operations in London to investigate the effects of Uber services on London's transport network and how the transport authorities were dealing with it, in terms of ridesourcing specific policies, regulations or other measures used to manage these types of services in the city.

How transport authorities deal with shared ridesourcing services such as Uberpool

The interviewees were asked various ridesourcing operations-related questions to explore how shared ridesourcing services such as Uberpool were being treated and whether there were any specific policies or regulations for these types of new mobility services. The interviewees were asked how "the transport authorities and regulators in London were dealing with Uber operations and if there were any guidelines or limitations provided to Uber and other ridesourcing service providers". The findings showed that the transport authorities were broadly unprepared for managing such disruptive services, and there has been no guidance developed for ridesourcing services in London. Accordingly, the transport authorities and the regulator were unsure of how to deal with these services. The responses included,

> "… one of the big challenges here for anyone making rules here for Uber or ridesourcing services, in general, is that the services that are advancing and developing so rapidly that it is as if a race is being run at two different speeds. The Ubers of the world that are involved in a 100-yard dash and the public sector is in rocking boat. This is always an issue when public and private sector entities interact, but here, the pace of change exacerbates…" (P2/I).

> "… the taxi and private hire vehicles were working amenably alongside each other until Uber came along; we just didn't foresee it was going to take off the way it did… I think there has been a bit of a defensive approach because Uber has come along, and we kind of got our fingers burned a bit because we suddenly got this massive number of drivers; Uber challenges everything we do because they don't like regulatory barriers…" (P3/A).

"… TfL's key remit in this isn't to ban these kinds of services but to regulate it, to make sure it meets the obligations under the taxi and private hire requirements…" (P18/A).

"… I think it depends a lot on how the company approached us. I think Uber very much got a strategy of drop it in, cause a lot of chaos and then deal with the consequences later, whereas other companies perhaps have been a lot more engaged with us. I think it depends a lot on how they treat us…" (P10/A).

Additionally, when asked if "there were any local policies that helped or hindered Uberpool operations in London", the interviewees confirmed that there were no Uberpool specific local policies except the general requirements that are set out as part of the PHV licencing and the high-level support for shared trips in the mayor’s transport strategy. The interviewees commented,

"They haven't designated anything specific to Uberpool; they should be encouraging the likes of Uberpool, because if we want to tackle congestion, as I said, thinking about more innovative ways of getting more people to use fewer vehicles..." (P4/R).

"… we are not restricting them, we don't have the wherewithal to restrict them, but clearly they've got to go through the registration and licensing process, so there is a registration and licensing process for a private hire vehicle. There is no additional restriction or legislation or statute in place…" (P14/A).

"… this is covered within the mayor's transport strategy; however, it doesn't sort of set a clear plan for that specific element. Generally, shared occupancy is a good thing, albeit it is still by road transport, and the main thrust of the mayor's transport strategy is to achieve that 80% sustainable mode share target, which is enormously demanding, so everything has to be seen in that context…" (P6/A).

Furthermore, in order to assess if the policymakers and transport authorities had the experience or organizational capacity to handle major disruption in the transport sector, the interviewees were asked how (and if) " they have previously dealt with disruptive or big impact innovations".

The findings indicated that most of the interviewees acknowledged that major innovative disruptions were rare in the transport sector, and they have not experienced the current level and type of disruption that is being caused by ridesourcing. The interviewees explained,

> "… it is difficult to make a comparison unless we talk about going back a very long time; almost to the impact of the motor vehicle itself. In terms of the modern era, I think it's been a huge factor, a change that it is hard to find a comparison. Certainly, the speed at which it has grown, the speed at which it has expanded. It is quite incredible for something that was founded only in about eight years ago in San Francisco, from nothing to operating in over 70 countries…" (P11/I).

> "… I don't know, really. There haven't been that many disruptive influences in public transport. Maybe that's the point. The biggest challenges are around declining demand for travel, generally. People are simply visiting cities and towns in Britain less, across all modes..." (P13/O).

> "… it is tricky because I would have to think about what kind of significant impact, so I think there probably haven't been that many shocks at this level, like the invention of the motor car in the first place…" (P7/A).
> "… disruptive influences are quite rare in transport, which is why I think a lot of people in the industry are panicking about it because it's not something we are necessarily used to. If you look at how bus services have been provided, for example, rail services have been provided, it's pretty much been the same for a hundred years…" (P20/A).

Furthermore, the interviewees were asked if there were "any existing or planned regulations for shared ridesourcing services such as Uberpool" to understand the regulatory landscape of which Uber operated in London and explore if any new regulations were being developed. The responses showed that transport regulators were not prepared to regulate shared ridesourcing services as there have been no new regulations developed and nothing was planned in the short-term but acknowledged that something needed to be done to manage these new mobility services. The shared ridesourcing services currently operate under the PHV licensing system, which was developed in 1998 and updated in 2000. These regulations were deemed generally outdated for ridesourcing services because the way ridesourcing services such as Uber operate is technically not a standard black cab service - which can be hailed or stopped on the street without prior booking - or a traditional minicab, which requires a pre-booking and cannot be hailed on the street. In addition, ridesourcing operators do not consider themselves taxi companies but technology companies and drivers were considered self-employed contractors (until a recent high court judgement in 2021). Therefore, the issues of ridesourcing regulations remain to be addressed by the regulators. The interviewees said,

> "There are no regulatory changes planned at all, at the moment… There comes a time where there is a whole proliferation of services that are completely unmanaged, unregulated; we then have to start thinking what powers we need to actually deal with this. You got to have some control. They are carrying passengers, offering transport for hire, people are paying fares, so it (kind of) fits into that whole public transport network, and we really need to have management of that…" (P3/A).

> "… it is not really carved out as a niche in the regulations whereas perhaps it should because it's almost treated the same way as just Uber standard, kind of like minicabs, and it probably does need a slightly different set of criteria, especially when you've got different fares being made. I think that then adds another layer of regulation…" (P10/A).

The findings further illustrate the need for both sides (i.e., policymakers/transport authorities and ridesourcing service providers) to work together to better develop, regulate and manage these new mobility solutions.

5.2.3 Theme 3: The Role of ridesourcing services in the future

During the final part of the interviews, all the participants were asked several questions and hypothetical scenarios about their views on the possible role that ridesourcing could play as part of a future transport system. The aim was to obtain sufficient data and insights on what the interviewees (particularly the representatives from transport authorities, regulators, PT operators and experts) thought about future transport systems considering the disruptions of ridesourcing services and their views on how it should be managed.

Dealing with ridesourcing services as part of a future transport system

The interviewees were asked if there were any plans that considered "ridesourcing services as part of future transport system", to gain a deeper understanding of the opinions of interviewees about ridesourcing services in the future and how these new services should be managed while considering its wider implications for traditional PT modes and congestion in the city. The results revealed policymakers supported innovation in the transport sector, but they were struggling to keep up with the pace of change. This was partly because of the time it takes to develop policies and regulations and get that approved through the many layers of bureaucracy in central and local government, but also the pace at which these new mobility services are being developed and introduced in cities was unprecedented. So, not only are there organisational capacity challenges but also administrative and political constraints. The interviewees explained,

> "Trying to answer that is what we are working on as a team (in TfL) and the business as a whole; what is our answer? once we can answer that, then I think we could probably answer a lot of other related questions..." (P10/A).

> "I think ridesharing and being able to take what would be a journey in a single car and kind of pooling them into one car, say multiple cars into single cars, is definitely helpful. We've set out a very clear vision that by 2041 we want 80% of journeys to be undertaken by public transport, walking, or cycling within Central London as part of the mayor's transport strategy and the only way to achieve that is to start pushing people away from private car ownership, so anything that can help with that is really helpful, but it will entirely depend on where it is…" (P9/A).

> "Thinking about how we can get evidence is one of the things. I think there's a bit of difficulty as well because of the pace at which these disruptive things come along; they can get a user base very quickly…" (P7/A).

> "…I think it's not easy to do; I think regulators such as TfL found it very difficult, obviously, to adjust to the technology. I mean, one good example of that is when they sued Uber over saying that the app is a taximeter and therefore it shouldn't operate

as a PHV service and of course, Uber did win that case, but I think it sort of shows cognitive cap in a way between people such as Uber and regulators…" (P11/I).

Moreover, the experts/transport innovators that were interviewed envisioned ridesourcing as a key part of the future transport system, specifically in an urban context, as it combines convenience, innovation, and efficiency. They stated,

"… the digitisation of private hire transport, which Uber has done, and smartphone enabled, definitely offers a new opportunity to change how we manage public transport and public transport subsidy…" (P15/I). However, there were no tangible ideas put forth on what this would entail.

"I think that ridesourcing services are much developed to offer flexible on-demand solutions that are more personalised and corresponding better to the way future generations travel, and we can already see now trends of multi-modality…" (P12/I).

"… looking towards the future, I think these kinds of services will be much more integrated into the public transport system. I think what could be optimised in those cities that have very good cooperation with taxis or with other on-demand services is the public transport system with shared ridesourcing and potentially shared autonomous vehicles…" (P13/O).

However, transport operators (i.e., PT bus operators) viewed ridesourcing both as an opportunity and as a challenge. During the interviews, PT operators both within Greater London and those that operated outside London highlighted the potential opportunities that on-demand mobility services can offer as part of a broader future transport service offering, but also the challenges, which the likes of Uber bring in terms of affecting bus patronage and service profitability. Several PT operators explained that they have already started to think about what ridesourcing would mean for their business models and how they can work with service providers or develop their own shared ridesourcing solutions, for example, Arriva group, who were developing an on-demand shared ridesourcing service called Arriva-click, initially as a pilot, but with a view for future rollout.

The interviewees said,

> "… We would look to collaborate with such services in the future, maybe as part of wider integrated transport services…" (P21/O)

> "… when a new competitor arises, you up the game, you compete better, get your own product better, make your own product of buses more attractive. There is potentially some scope for being complementary, probably less so with buses than with trains…" (P13/O).

> "… Uber is already going to different councils, even in the UK, saying, rather than you procure a dial-a-ride bus service in a rural area, could you procure us (Uber) and our drivers. They're looking at not just taking revenues from travellers but also, taking revenues from government…" (P15/I).

> "I am aware of the in-service trials of demand aggregating platforms, and those two are SLIDE which is being done in Bristol by the RATP Group and Arriva-Click, which is being trialled in Sittingbourne by Arriva…" (P8/A).

None of the transport operators interviewed (including some that operated across the UK and internationally) knew the actual impact of ridesourcing services such as Uber on their traditional PT operations as they did not collect any data related to ridesourcing and whether PT passengers were switching to services like Uber.

Hypothetical scenarios about the effects and role of ridesourcing services in the future

The final element of the interviews included three hypothetical scenarios that aimed to gain further insights and perspectives from the interviewees on how ridesourcing should be managed or what they thought ought to happen under each 'what if' scenario. The hypothetical scenarios were used to supplement the interview questions, and each scenario focused on a plausible future situation caused by or involving ridesourcing services. It also provided the interviewees with an opportunity to give more information on aspects that were not covered in the main interview questions whilst providing the opportunity to explore the viewpoints of interviewees about the role of ridesourcing in the future, considering how their views might change (or be different) based on the scenario and the interviewee's role.

For the first scenario, the participants were asked to clarify what they thought should be done "if the introduction of Uber was adding more cars to the road and as a result creating more congestion and emissions". Most interviewees explained that it should be managed using a combination of taxation and regulation, which may include aspects of congestion charge type levies. Besides, a holistic approach should be adopted, which looks at all car usage and ways to reduce it by providing better PT and sustainable alternatives whilst capping the number of PHVs (includes ridesourcing). The interviewees said,

> "… I think that there are a number of mechanisms that should be done. There are the capping licenses, the taxation because, at the moment, taxis and PHVs can get certain advantages, like being able to use bus lanes, so yes, either fiscal or physically limit…" (P17/A).

> "More traffic and more emissions are completely the opposite of what we want to achieve in Central London or in anywhere in London and so whether or not if we had the powers to cap the number of vehicles then we would obviously be wanting to use that, but we would be campaigning heavily for central government control. We would be putting in as much controls as possible to deal with those kinds of things, but it would be very difficult to specifically target a company. It would have to be done through a fair wage or a competition, not just because Uber is the problem…" (P9/A).

> "… I don't think we should deal with it by dealing just with Uber. You have to deal with it by having a joined-up policy for all vehicles, of which Uber are a component. So, it is not an Uber policy, but a vehicle policy…" (P14/A).

> "… I think the actions really needed to be taken are about curbing the use of private vehicles and educating people to understand and to accept the real costs of using private vehicles, both to themselves, but also to the environment and to the economy and to the society in general. And then, beyond that, it's more of the case of taking some carrot and stick approach, that you need to make sure there is adequate, high

quality, reliable, punctual, affordable public transport in place and at the same time, we need to be taking action to restrict the use of cars, restrict the road space available to them, restrict parking availability and thereby, you are actually pushing people in the direction that they will be able to maintain the journey habits or similar journey habits that are productive for the national economy, contribute towards things like people's health and wellbeing" (P16/O).

It is currently not possible to distinguish the number of registered PHVs in London operating under ridesourcing services such as Uber, so the importance of which vehicles are being used for what business or purpose was also highlighted.

For the second scenario, the interviewees were asked to comment on what they thought should be done, "If Uber was reducing car ownership on the one hand but taking passengers away from PT (both bus and rail) on the other". The answers indicated that ridesourcing services should be encouraged where they complement PT services, reduce single-occupancy vehicles and car ownership. For example, to cater to key first/last mile trips and areas where bus ridership is low or has limited services. A policymaker said,

"… where I think we probably want to put more thought in the future and which might start to be incorporated more, is guidelines to local authorities to try to encourage these services to be complementary to public transport…" (P7/A).

In addition, a PT bus operator stated,

"... I think the reason for smaller more agile vehicles are not in direct competition to the big buses, I think they should be in places the big buses don't go at all, so I would say the latest CM2 from City-mapper (an on-demand mobility provider) saying we've actually studied this as a whole and people want to go from this place and that place, and nobody served it or do it on the edges in the middle of the night or on the outskirts that's where the TNCs (i.e. Uber) should support" (P23/O). Further information about the Citymapper service is provided in (Medium, 2017; Citymapper, 2017).

Most PT operators and local transport authority interviewees hoped shared ridesourcing supports PT usage in the longer term; although they are not sure how this will happen, however, they recognised that the efficiency and attractiveness of PT services need to be enhanced, especially bus services where ridership has been decreasing in recent years. Moreover, the policymakers and PT operators mentioned the importance of focusing on first/last mile trips, where ridership is already low on existing routes and areas with limited access to PT. However, this is rather the opposite of areas where Uber currently focuses and is suited, such as high density, high demand areas, which are also the locations with the highest PT accessibility levels, such as zone one in London.

Accordingly, if Uber is to support the provision of shared transport services in low-density areas where PT is limited, policymakers need to recognise the need to work with PT operators and shared ridesourcing service providers to establish a model that works for all parties involved and benefits the public users. This could include incentives or subsidies to attract ridesourcing service providers that are profit-making to work in such areas. Again, some lessons should be learnt from cases in the USA. For example, transport agencies in San Joaquin (California) and Pinellas County (Florida) have signed agreements with Uber Transit (a dedicated service that works with transport agencies) to provide subsidised Uber services to fill gaps in the transport network in places where fixed route or demand response services have been reduced or cancelled (Uber, 2021; Bloomberg, 2021). However, in London, the way public bus services are procured would need changing if these types of collaborations with ridesourcing service providers are to be used. Additionally, the collection of data specific to ridesourcing and its effects, undertaking pilot initiatives with the private sector and innovators, was highlighted as an important part of the learning and developmental stage of these new shared mobility services. The interviewees explained,

> "… you need to integrate the two a lot more as much as you can; certainly, there is a threat with Uber and that it can take away from public transport… If you can integrate it more into your total network talking about the first mile and last mile, into the wider networks; you don't want to see public transport reduced, but on the other hand do we have to look and say perhaps in areas where bus service isn't viable, do we have to look at Uber-type service. I think certainly in some rural areas. I think dial-

a-ride and these sorts of services; we need to have a fresh look at. Demand responsive transport, how we integrate Uber into these wider systems, not just sort of say, is Uber hitting bus services…" (P11/I).

"… either you bring it (i.e., ridesourcing) within the operation of PT, so PT operators like FirstGroup, Stagecoach, GoAhead and Arriva, actually absorb the operation of Uber and provide it just as parts of an integrated transport service, but that can't be made to work, and clearly there would need to be something to be done to reduce its spread, whilst reducing car ownership, and usage is absolutely something that is going to be positive and beneficial because the usage of the Uber vehicles is going to be shared and therefore they are going to be used more efficiently…" (P16/O).

"… public transport needs to get more innovative; PT can't sit there and be all like well, I'll just do my double-deck, red bus or my Tube. PT needs to meet the demand of the customer. In certain cities around the world, they're quite adaptive at that. In other cities, they're not so just because it's a public service doesn't mean it shouldn't adapt to the new technology. That is my personal view is that they need to adapt because otherwise they'll get left for dead…" (P21/O).

For the third and final scenario, the interviewees were asked what should be done, "If Uber started to offer other shared transport services, for example, demand-responsive van or minibus services or a type of MaaS, where the use of Uberpool and UberX was central". Most interviewees expressed that these types of services are generally welcomed both from the PT operators and transport authorities; however, it was explained that it should be piloted in specific areas and use cases and should have a clear economic case. Moreover, it was said that suburban locations with limited PT services or routes with low PT bus ridership might benefit from an on-demand small bus service that is integrated with the broader city PT network. The importance of collaboration between the transport authorities and private sector ridesourcing operators was highlighted in order to make this scenario work.

The interviewees said,

> "… it sounds like something worth considering; I don't think a city should accept it with open arms. I think with anything like this; generally, you try it out as a pilot project, and you test it out in a certain area, and you evaluate it…" (P5/I).

> "… it is that grey area, that gap between the bus network and the private hire system and we see people are coming looking to fill that gap and, in some places, it might be suitable, because there are some areas in suburban London for example, which are actually quite transport poor and its quite difficult, you got to walk a long way to a bus stop. In central London, we don't need it there is enough transport within central London we don't need any more players in the market…" (P3/A).

> "… we should cooperate, and PT should cooperate with Uber. I mean, we need these types of service to offer more flexible and personalised transport to citizens, because this is what citizens expect; and that will make some PT networks more efficient, so we need actors that will operate these services, or maybe we can do that in partnerships, or we go operate them ourselves…" (P12/I).

> "… we should encourage that if they can find a commercial business on shared buses, why should PT operators be driving those buses. But I think it will end up in public/private partnership in somehow the public authorities will sponsor this and if they withdraw their buses that they have done on a tender and Uber drives them instead, and maybe Uber gets some benefits, tax reduction or whatever it could be. It is positive and I think the public sector shouldn't it's more political point of view probably, today we have transport on demand, buses on demand that is organised by the PT authorities, it's not well organised we all know that and it's not efficient so if they can find a way of saying that okay can you take care of the accessibility to transport services in this area, please do…" (P22/A).

5.3 Chapter Summary

This chapter presented the results from the qualitative data that was collected using interviews with 31 participants from transport authorities and policymakers, PT operators, industry experts and innovators, and ridesourcing service providers. This part of the research set out to understand the challenges and opportunities arising from Uberpool operations. In addition, to explore how policymakers, transport authorities and the PT sector were dealing with Uberpool and Uber services in general, and if there was any data or understanding about the impacts of ridesourcing services on traditional PT modes and congestion in London.

The findings showed that the viewpoints of interviewees were varied; however, most of them were unsure about how to deal with ridesourcing services, and there were no immediate plans for managing these services. Moreover, the findings revealed that there are no mechanisms currently in place to monitor or assess the impacts of ridesourcing services in London, which results in a genuine lack of knowledge and empirical data among policymakers and transport authorities to inform how they approach these services in terms of regulations, operational guidelines, integration with other modes and future transport systems. The PT bus operators appeared to be more proactive in terms of looking at on-demand shared solutions that may complement some bus services or fill gaps in the network. For example, Tower Transit with the CM2 service (an on-demand night bus service from City Mapper and operated by Tower Transit with the Impact Group) operated between Aldgate East and Highbury & Islington via Shoreditch and Dalston and Arriva-Click service (another on-demand and flexible luxury minibus service by Arriva bus).

Generally, the interviewees acknowledged that ridesourcing services are popular with users and are providing a convenient and cost-effective transport service to users, but lack of data, rapid pace of change, lack of understanding of its impacts due to limited data and (to some extent) political-will, have all contributed to inactivity from regulators, policymakers, and PT authorities. Additionally, the PT operators indicated the lack of innovation and integration with new mobility solutions was mainly due to how PT bus service contracts were set up in London because it is a fixed-term and fixed-route contract regardless of the number of users for each route. So, operators are looking to TfL, which contracts all PT bus services in the city, to guide how services are planned and provided in the era of new (shared and on-demand) mobility services.

Overall, there was a general understanding among the interviewees about how the Uberpool service operated, and the shared concept was viewed positively as part of a future transport system, providing it is used to fill gaps in the PT network or at low bus ridership routes.

Interviewees indicated that a holistic approach should be adopted when managing ridesourcing services using a combination of taxation and regulation that considers congestion levels and impacts on PT services. Also, PT operators recognised that the efficiency and attractiveness of PT services need to be enhanced, especially bus services, to reduce the impact of new services such as ridesourcing on traditional PT modes. Moreover, the transport authorities were concerned about the safety of passengers using the service. There were indications that policymakers and the PT sector have not caught up with the level of disruption caused by new technology-driven mobility services such as Uber, both from policymaking and operational perspectives. Uber appears to be ahead of the transport regulators and has generally benefited from the absence of strict regulations and or limits on driver numbers or where they operate in the city. Accordingly, there is a need to recognise the full costs and benefits from ridesourcing services for the city, users, and drivers, including addressing driver labour issues (i.e., working hours, pay, employee benefits) and deciding ways ridesourcing operators can play their part in reducing any adverse effects.

The findings contributed to answering one of the main research questions from the perspectives of policymakers, PT operators, transport authorities in London and other key stakeholders, including ridesourcing service providers, to help build an inclusive understanding of the main challenges and opportunities that were resulting from the introduction of Uber in London and how they were dealing with Uber services such as Uberpool.

The next chapter will provide the results from the London Uber drivers focus group qualitative data analysis. The focus groups were designed to complement the qualitative interview data, thus helping to answer the research questions, particularly on how Uberpool and UberX services are used and why users adopted Uberpool instead of other modes. In addition, to obtaining other insights, first-hand experiences, and general perspectives of London Uber drivers.

Chapter 6: Focus groups results

6.1 Introduction

For this research, three focus group sessions were held, and qualitative data were collected from Uber drivers in London. The aim was to obtain valuable data and insights directly from Uber drivers to help answers several critical research questions, including how Uberpool services are currently used in London and what attracts travellers to the service. With the absence of data from ridesourcing service providers like Uber, the drivers' viewpoints and experiences were considered important to understand more about key aspects of the service, which the drivers had first-hand experiences. For example, the different users, the main operational challenges, and opportunities, how the transport authorities and Uber dealt with the drivers and feedback about the different service options offered via the Uber App. The data from the Uber drivers were used to complement the user surveys and interview data to offer a holistic approach that considers the views and inputs from all those involved in the operations and usage of the service. Also, this helps to address one of the research gaps identified in Chapter Two.

This chapter presents the key findings on how Uberpool services are used, the main characteristics of Uberpool users in London and why travellers have chosen the service over other modes of transport. Moreover, details of the emerging operational and Uber driver welfare consequences are described and then a chapter summary is provided.

6.1 Uber Drivers in London: Focus Groups Results

The qualitative data collected from 28 Uber drivers during three focus group sessions in London were analysed. The Uber drivers' key characteristics, along with the participants' recruitment process and the methods used, are presented in Chapter Three of the thesis. The results were organised into main themes and sub-themes for ease of interpretation and to gain meaningful outcomes to answer the main research questions. The main themes included the Use of Uberpool; User Characteristics; Reasons for using Uberpool, and the emerging operational and Uber driver welfare implications.

During the analysis, the data from the focus groups were anonymised. Accordingly, when reading the results from the focus groups, the letter [D] with the number represents the driver identity number that was allocated during each focus group session. For example, D1 means driver number one, and the letter [S][1] with the number denotes the focus group session, e.g. (D1/S2) means driver number one in focus group session two. The key findings for each theme are presented in the subsequent sections.

6.1.1 Theme 1: Use of Uberpool

When are Uberpool services used, and for what trip purpose?

To understand when Uberpool services were being used the most and the main trip purposes, the focus group participants were asked, "when is the demand high for Uberpool service and what were the main trip purposes". The participants indicated that Uberpool mainly was being used during the night, weekends, and early mornings. Moreover, the service was mainly used to go home after a night out, for longer journeys or to/from university or college. The participants explained that:

> "… it is used at nights, weekends and early mornings…" (D5/S1).
>
> "… mainly night-time, late hours when mostly there is surge price, so people try to reduce their taxi fare by using Uberpool…" (D4/S3).
>
> "… the service is used during morning and afternoon peaks when people are going to and from work, school or university and weekends when people go out in the city…" (D8/S1).

Additionally, they mentioned that Uberpool is mainly used by:

> "… Uberpool is used by those going longer distances…" (D3/S1).
>
> "… it is used by mostly those going home after a night out…" (D6/S3).
>
> "… students going to and from university or college use it a lot…" (D8/S3).

Areas of high usage and percentage of Uberpool trips

The Uber drivers were also asked to comment about the areas in London where travellers were using Uberpool and UberX services the most. The responses showed that the service was popular in central London and south London areas, where PT access was limited.

[1] When reading the results, the letter [S] stands for 'session'.

> "… for pick-ups, it is mainly in the central areas, Zone one, but the drop-offs are mainly south or south-east because it has less public transport access. However, it depends on their destinations. So Uberpool is mainly requested in the central areas" (D5/S3).

> "… Uberpool is used a lot in the southern areas of London, because of limited public transport and central London areas, especially evenings and weekends, for example, the Strand, Soho and Covent Garden areas" (D8/S3).

> "… mostly they go south and central London areas, Zone one…" (D2/S1).

Additionally, when asked about how many Uberpool trips they served on a typical shift. The participants stated that approximately 20 to 30 percentage of the daily Uber requests per driver were commonly Uberpool trips; however, drivers disliked accepting Uberpool requests because of the amount of commission they must pay. The participants explained that:

> "…it varies, so for instance on the weekend… I would say it is 30% because it is very popular…" (D1/S1).

> "… if you start at 07.00 in the morning until 16.00, you can get an average of 15 jobs, and maybe 4 or 5 would be Uberpool. If I were accepting all the Uberpool requests, I could easily do 20 plus jobs, and 7 or 8 would be Uberpool…" (D8/S3).

> "I would say 30-40%. It was easier to decline Uberpool jobs before, but nowadays, Uber contact you if they see you are not accepting Uberpool trips, and they say that you are breaking the agreement" (D9/S3).

Research data gathered using methods like focus groups sometimes suffers from biased responses from participants due to personal experiences or vested interests. to minimise this, the data from the three different focus group sessions were reviewed and compared, particularly on the key points reported. Since the participants at different focus group sessions were based in different parts of London and did not necessarily know each other, it was concluded that the feedback obtained and reported for theme one was representative of Uber driver perspectives, and therefore valid and consistent across the three focus group sessions.

6.1.2 Theme 2: Uberpool User Characteristics

Who are the core users of Uberpool?

To understand more about the travellers who generally use Uberpool and their main characteristics, the focus group participants were asked: "who the main users of Uberpool were". The most common responses are provided below, in order of importance:

1. **Students**

Students were said to be the primary users, which was mainly attributed to many students not having a car and willing to share rides in order to save on transport cost. Participants also indicated that many students travelled in groups using Uberpool, be it to and from college/university or social events/activities. Many users preferred the convenience of Uberpool instead of PT and owning a car with all the additional operating costs.

"It is used by students going to and from university/college…" (D8/S4).

"Students use it a lot because it is cheap" (D5/S3).

"… It is mainly used by low-income groups and young people, including students…" (D9/S3).

2. **People making social trips**

The use of Uberpool to and from social events/activities (i.e., *on a night-out)* was often mentioned during all the focus group sessions. Some of the reasons given included saving trip costs, socialise whilst going to/from events/activities and because users were flexible on journey time. According to the drivers, these trips are mainly made during the evenings and weekends and sometimes intensified by the price surge system that Uber implements during busy periods.

"The users are mainly partygoers, those who go out at night…" (D1/S1).

"It is mainly trips going home after a night out in the city…" (D10/S3).

3. **Highly cost-sensitive users**

Participants stated many Uberpool users' avail of the service to avoid paying the higher cost of standard UberX services (especially during the surge price period), including many "cost-sensitive" professionals who use Uberpool to reduce trip cost. The participants explained that,

"Uberpool is all about saving money, it is about distance. If a person wants to go a couple of miles, he does not need the hassle; they just use the normal standard ride (UberX). If he/she is going long-distance, he/she goes for the Uberpool option that is where he/she can save money and on top of that, if he/she is in zone one (central London area) and the surge price is high they use Uberpool, because they will save a lot in terms of the surge and the base fare…"(D1/S1).

"… It is all about saving money, so if you are smart enough, it is the people that are educated and know the system, and the majority are younger generation…" (D1/S1).

"… for the customer, saving money is a positive thing …" (D1/S3).

"… most of the users are middle class there is this perception that Uber users are the less well off, not the middle class…" (D3/S1).

4. **Travellers making long distance trips**

During all three focus group sessions, participants asserted that users often choose Uberpool for longer distance journeys, which corresponds with other feedback from users during the pilot survey. Shared longer distance trips using Uberpool with three or more passengers would sometimes be cheaper, quicker, and more convenient than PT modes. Some drivers reported regular long-distance trips to airports or suburbs, which users would regularly book with the same driver.

"Uberpool is used by those going longer distance…" (D3/S1). "… they split the normal fare…" (D4/S1).

"There are also fixed group trips; for example, I take six people to Surbiton every week, and they split the trip cost…" (D2/S).

"Uberpool trips are mainly longer trips because people make the most saving from longer trips by sharing…" (D10/S3).

"… if passengers are going a longer distance, they go for Uberpool option, that is where they can save money…" (D1/S1).

The general feedback from the focus group participants about the main users of Uberpool broadly reflected on first-hand experiences gained whilst they were working for Uber, including some vivid descriptions of specific trips or experiences. Therefore, the data were considered sound. However, although most of the findings correlated with the survey data, it was acknowledged that there might have been some overemphasis about why they thought cost-sensitive travellers sometimes used Uberpool.

6.1.3 Theme 3: Reasons for using Uberpool

Why do travellers use Uberpool in London?

During the focus group sessions, The Uber drivers were asked about "the main reasons they think travellers in London use Uberpool". The five most prominent findings from the discussions are presented below in order of importance.

1. **Cost of Uberpool compared to UberX, PT, Conventional Minicab, and Black Taxi Services**

The participants confirmed that Uberpool services were cheaper compared to standard UberX, PT (i.e., compared to longer shared Uberpool trips), conventional minicab and black cab services. This vital point was highlighted repeatedly by the focus group participants in all three focus group sessions.

"Many people use Uber instead of PT. Sometimes it is even cheaper/more cost-effective to use Uber if you are a group of four…" (D2/S3).

"… the service is approximately 25% cheaper compared to UberX and even (more) cheaper compared to black cab" (D1/S3).

"… for the customer, it is cheaper, regardless of whether or not you have a second rider…" (D6/S3).

"… mainly because it is cheap and Uber also made a lot of advertisement, in the beginning, saying it is cheap…" (D5/S3).

The results from the data analysis showed that participants considered this the most important factor. Uberpool is offered as a low-cost shared transport service, using private hire vehicles, which explains why it appeals to those looking for a cheaper taxi-type service with the convenience of requesting and paying using a smartphone app.

2. Convenience

The focus group participants mutually agreed that the service is considered convenient, compared to PT and conventional minicab or black cab services. Convenience in this context referred to the ease of requesting and paying (i.e., via smartphone app) for trips, knowing the estimated trip cost and duration in advance and the overall accessibility of the Uber services compared to the other modes. Accordingly, the participants highlighted "convenience" as the second most important motivation for users to use Uberpool and Uber services in general.

"… it enhances and supports PT because of its convenience and the pricing as PT services are getting expensive and is getting harder for people to get reliable transport from point to point; therefore, Uberpool is convenient, reliable and cheap and therefore complementary…" (D1/S1).

"You get many customers who say they used to use black cabs when they go drinking because it was more convenient for them. However, now Uber is cheaper and convenient because even when you are completely drunk, and the person does not know where they are or where they are going, they can just press the request button where his/her location is picked up automatically by the system and the 'HOME' button for where they are going…" (D5/S3).

"… it is kind of adding to PT because it caters for a lot of drunk people from central London and then takes them to their destination quicker…" (D2/S2).

This point was concerning the Uber services and specifically Uberpool service being able to fill gaps in the PT network and, in some cases, provide linkage to public transport hubs as some of the busiest pick-up locations were said to be near large stations (this is further elaborated in the next sub-section). A participant explained that,

"… majority of the trips are near PT stations, for example, if you go now to Crystal Palace station, you will always see very high demand. They always come out of the station and take Uber" (D3/S1).

The use of the Uber app for this service and knowing, upfront, the cost, estimated trip duration and being picked up generally at the passenger's location (or very close) were all indicated to be essential elements of convenience, especially during late hours. Besides, Uberpool services were readily available in London's central areas and generally arrived quicker (within 2 to 4 minutes) compared to the public transport services and conventional minicab and black cab service. Uberpool was also very convenient and cost-effective for groups of 3 to 7 people for specific trips such as airport and longer trips and during surge price periods when the standard rate for UberX goes up because of high demand for Uber services, which is very common at night.

3. Ease of request and payment

The ease of requesting and paying for the service using the smartphone app was mentioned as a crucial factor, which correlates with previous literature findings, e.g., Rayle et al. (2014) & Chen (2015) and feedback from users of the service during the pilot survey. The Uber drivers often received feedback that passengers used Uber services because of the ease of requesting and paying for the service, especially during social trips at night (i.e., nights out), where having the correct change and finding a conventional minicab office or black cab was said to be complicated.

"… Customers often praise Uber services, for example, the booking system and the ease of ordering, ease of use and payment using the app instantly…" (D3/S1).

"… the ease of requesting and payment since they pay via the App, using a credit card…" (D6/S3).

The participants highlighted another vital aspect of how the Uber App is used to request for the Uber services and facilitate Uber fare splitting (i.e., sharing the trip cost amongst passengers on the same trip), which was considered essential for some user groups such as students or friends going to social events.

> "… it is done directly on the Uber app, one passenger makes the request for the trip, but invites the other passengers on a fare split basis, so they basically pay for one trip fare but split the cost amongst each other…" (D4/S1).
>
> "… they can do the split fare, before, during or after the trip…" (D2/S1).

4. Socialising during Uberpool trip

Passengers that were using Uberpool to (specifically) meet another passenger for socialising during the trip were featured in all three focus group sessions. The Uber drivers stated some Uberpool passengers often mentioned one of the main reasons they prefer Uberpool is to meet someone during the journey - mainly of the opposite gender - and would often try to pick up dates during trips.

> "… you also get some people that use Uberpool, for socialising and getting dates. I had several customers who requested if I could only accept the opposite gender as the second pooler, so they try to get a date…" (D10/S3).
>
> "… people use Uberpool sometimes to meet people (i.e., get a date) …" (D3/S2).
>
> "… some people use Uberpool to find a date, there were many customers that I took, who said they were looking for a date, including lady customers…" (D8/S1).

Information from Uber and mainstream media supports this point, with some real-life examples of people who met using Uberpool trips, including those who even got married as a result. In the era of dating and social media apps, some people still seem to prefer meeting in real life while carrying out a key daily activity, travelling.

5. Requested by mistake

Travellers requesting Uberpool by mistake were reported as a common occurrence during the early days of the service in London, when most people were not familiar with the service and did not think they would be sharing with a stranger. It was also common during night trips when people are looking for the cheapest Uber ride, and they want to avoid high surge prices during busy periods, and they often find out that they requested a sharing service when the driver stops to pick someone else along the journey.

> "Some passengers order it by mistake because they do not know what Uberpool means…" (D7/S3).

> "Many people request Uberpool by mistake, but the problem is many people do not know the technology. Some of them press the Uberpool option accidentally…" (D1/S1).

> "… the routing to collect other customers and people ordering Uberpool by mistake is an issue…" (D8/S3).

> "… a lot of people order by mistake, without knowing what Uberpool is…" (D7/S3).

Participants reported that this sometimes-caused issues and that they often had to explain what Uberpool service is and how it works in addition to mediating when issues arise between passengers.

> "I took an Uberpool passenger once, and after a few minutes, I picked up another Uberpool customer who was in a hurry but did not realise that Uberpool meant sharing. Then they started arguing in the car. I had to explain and mediate between the two…" D8/S3).

Uberpool and other modes of transport (i.e., PT, Active modes, UberX, black cab/minicab)

To understand the effects that Uberpool may have on other modes of transport such as PT, Active modes, UberX, black cab and minicab services. The participants were asked about "the modes they thought Uberpool was competing with" and if the services affected the main PT services and active modes. The participants explained that the main competitors in central London were black cabs and PT services, specifically the 24hr night Tube services. However, that was not the case in South London areas where black cabs did not go often and that had limited or no Tube services.

The participants also described that in their view, Uber services in general and Uberpool specifically were not affecting PT services negatively. However, it provided a complementary service that connected travellers to PT stops and stations (for example in some south London areas that have limited or no Tube service) or catered for travel demand during special events or train/Tube strikes, or late at night. They also thought people choose Uberpool primarily because of the cheaper fare. However, there were some concerns that the service was affecting walking and cycling trips since Uber drivers were noticing many short trips that could otherwise be walked or cycled.

When asked about the main competitors to Uberpool service in in central London, participants said:

> "… mainly the black cab services, but during the night it's the night Tube" (D4/S3).

> "… public transport, since the 24hrs Tube service started, demand for Uber went down." (D6/S2).

When questioned about the effects on PT trips, the participants explained.

> "… I believe it complements public transport. It is helping the people who use buses or trains but are running late or those that are far away from the stops or stations. They simply request Uber, and we take them there quickly" (D5/S1)

> "… it has helped the public transport a lot in three ways; first, whenever there is a strike or jam on the public transport network, Uber helps out a lot. For example, if there is an incident at Clapham Junction Station, the trains are stopped, and all the passengers need to reach their destination, so most of them use Uber" (D7/S3).

Concerning the effects on walking and cycling trips, the participants said.

> "… previously people used to walk, but because this summer was too hot, people prefer to take Uberpool" (D9/S1).

> "Yes, especially at night, someone who might have walked or cycled, they
> will take Uber, even a short distance, because it's cheap and safe" (D8/S3).

> "… yes, it is affecting a lot of short local trips, which could normally be made by walking or cycling" (D4/S3).

"… it has some effect because it is cheap and easier to use Uberpool, so instead of walking 1 or 2 miles to/from home, they use Uberpool which would be around £2 to £3…" (D1/S1).

Furthermore, when asked about why they thought people choose Uberpool instead of UberX, the participants said:

"… mainly because it is a cheaper service, and the odd person who wants to socialise" (D8/S2).

"… a lot of people order by mistake, without knowing what Uberpool is…" (D7/S3).

"… because it is cheaper. But I heard a lot of people had stopped using Uberpool because when they had one or two bad experiences, in the beginning, they do not use it anymore" (D4/S3).

Furthermore, to understand the transport modes that Uberpool users were using before the service became available in London, the participants were asked: "if passengers commented about the transport option they were using before Uber". The responses showed that many Uberpool users previously used minicabs, black cabs, or PT for similar trips. There was also feedback that revealed some passengers said that Uber had provided them access to transport, including customers that were using a for-hire service of any type for the first time, signalling that Uberpool might play a role to fill gaps in the transport network or help people with accessibility challenges. The primary responses included.

"… many customers comment, they are ex black cab users…" (D9/S2).

"… they say either normal minicab or public transport…" (D10/S3).

"There are those who used to use night bus after a night out, but now use Uber services due to convenience and safety, and it is cheap…" (D7/S2).

"… customers say, they used to use Addison Lee, and it is a rip-off, black cab is also a rip-off, local taxi charge more compared to Uberpool..." (D2/S2).

"… since Uber was introduced, everyone can afford a minicab type service, people who never were able to afford a minicab before are now able to use Uber because its cheap. So, this has given everyone access to a car…" (D3/S2).

"… some customers say they never used to take taxis or minicabs and Uber made it possible for them to take taxi/minicab…" (D8/S2).

"… some people say they did not use to go out most of the time (i.e., night/weekends) because they were not sure how they would get back home later. Sometimes, when they stop a black cab, they would get refused, especially if they are going to the outskirts of London because the black cab knows they will not get a new ride from those outskirt locations at late night. Also, the minicabs were too much hassle. So, a lot of customers find it convenient and hassle-free to use Uber" (D4/S3).

Cost of Using Uberpool compared to UberX and Taxi/Minicab

The participants were asked about the "cost of Uberpool service compared to standard UberX service", and the most frequent response was that Uberpool was cheaper compared to UberX by approximately 15% to 25%, which is somewhat less than data published by Uber at the time of data collection (see, Uber, 2014), that indicated passengers could save up to 40% by using Uberpool. The service was considered more cost-effective than public transport, for a certain number of passengers and particular trip types, for example, trips carrying more than three passengers going to the airport or going from central London to the suburbs late at night.

"… It is 25% cheaper all the time, customers are saving money…" (D3/S1).

"… for the customer, it is cheaper, regardless of whether you have the second rider or not…" (D6/S2).

"… it is 25% cheaper for the customer, but you have to remember; they may take you off route and because of that many people complain…" (D4/S3).

"… around 30-40% when it first started and requests for Uberpool were very frequent…" (D8/S3).

Although most participants agreed that Uberpool was cheaper than UberX and that it was economically beneficial for the travellers, it was disliked by most drivers because of the commission structure and journey times for Uberpool trips. Moreover, the amount of fare savings was also dependent on whether the trip request was made during a surge price period or off-peak timing.

"… Uberpool is 25% cheaper than UberX, and then Uber takes 35% commission; you are left with peanuts. So, you are worse off as a driver. As a passenger, they are much better off; they get discounted fare, which is 25% cheaper…" (D8/S2). "…it is cheaper, but for the driver, it is better when there is no second pooler because the commission is less, and you save time. If it is only one pooler, the commission that Uber charges the driver is 10%, but if you pick up a second pooler, that increases to 35%" [D8/S3).

"The surge pricing is a percentage increase across the board, so if the surge is 2.0%, then this is applied across all Uber services…" (D1/S2).

"… but Uberpool still gets discounted, overall cost. So, the customer still pays 25% less during the surge price period compared to UberX, so it is still cheap…" [D9/S2).

"… when you pick up one rider, that customer saves around 25% of the fare; it is automated. When you pick up two, they save 25% of the fare; the company gets a 35% commission for the two. For one ride, what happens as a driver. The rider gets a 25% discount automated. As a driver, the company gets 10% instead of 35%, so the company loses. So, Uber will try and force you to pick up the two because the benefit is for the company. The two passengers will always, whether they join or do not join, they will always get that 25% automatic discount. If you are getting two customers, you are losing a lot of money. The driver is a loser when its two riders" (D1/S1).

During the focus group sessions, the Uber drivers provided a lot of information and personal experience of why travellers use Uberpool. According to the Uber drivers, the main reasons travellers used Uberpool in London included the cost of the service compared to UberX and other modes, including PT, the ability to socialise during trips, and the convenience and ease of requesting the service. The data included detailed explanations about the pricing and commission structure of Uberpool compared to UberX and the drivers' perceived views on the benefits and disbenefits of Uberpool for the users and drivers. Some of the feedback for this theme corresponds with the similar findings from the Uber user surveys and also previous literature on ridesourcing, particularly on the convenience of the service, socialising during the trip, the cost compared with UberX or traditional taxi and ease of requests. However, it is recognised that participants might have exaggerated some of the points relating to how good or cost-effective the service is compared to PT and their views about the black taxi, minicab services and other modes that Uber is impacting. This might have been motivated by the need to portray Uber services as superior for the users compared to its main competitors.

6.1.4 Theme 4: Emerging operational and Uber driver welfare implications

During the data collection stage of this research, there were several ongoing issues such as the case between Uber and TfL regarding the non-renewal of Uber operating licence, and the court cases brought about by some Uber drivers regarding Uber drivers' labour rights, which might have shaped some responses from the participants. Both cases have since been resolved by the high court after the empirical data was collected and analysed, and it is not clear how this would affect the results from the focus group sessions, particularly regarding drivers' welfare and transport authorities (i.e., TfL) related issues. Further discussion of key points is provided in Chapter 8 of the thesis.

Uber and the transport authorities

To assess any emerging challenges that Uber drivers have experienced with the local transport authorities such as TfL and any related operational issues, the focus group participants were asked: "how the transport authorities were currently dealing with Uber operations and if they provided any guidance or set limitations". During the three focus group sessions, the participants felt that TfL mainly targeted Uber drivers and intimidated them using inspectors and using special requirements such as the English language test. Moreover, drivers believed that the black cab lobby groups and their unions heavily influenced TfL's approach, and as a result, the Uber services and the drivers were being treated harshly.

"… they make everything difficult for us, and they put cameras everywhere, both TfL and the Boroughs, which are sometimes worse. Most of the Uber drivers are from ethnic minority communities, and it is always difficult to deal with the authorities; for example, I have one case where a customer ordered Uber in Hackney, where I had to stop at black cab and motorbikes only space, to pick her up, and they issued a fine of £130. So, why would they allow a black cab and not an Uber? We are effectively providing the same service. I have fulfilled all the requirements of a licenced private hire vehicle driver, so it should be the same" (D6/S2).

"TfL have been lobbied and pressured by the black cab lobby groups, and they are a lot stricter with Uber drivers, and they punish us all the time. Their inspectors are in all the busy areas like Soho, airports, and whenever they see an Uber vehicle, they will come to you and start hustling you and inspecting your car. Sometimes they even bring police officers. If they see any little thing, or you don't have your papers with you, they will suspend your licence or give you a warning or fine if it is your first time…" (D9/S3)

"… Uber is creating congestion in the city; it is too much. Its pollution as well, so what they are trying to do is control it, so they will have to make the licence very hard, they have to restrict it at the same time, they have to show they are in line and supporting the black cab, which is an icon, an industry by itself, so they are protecting it. The black cab is good for tourism, they have the politicians behind it, and they have the money and unions…" (D1/S1).

Uber Drivers' rights

The participants were asked if Uber drivers' rights were regulated or protected by the regulators or Uber. The drivers keenly explained that they felt that neither the regulators nor Uber were looking after the driver's welfare, and they were always at risk of being removed from the Uber system and, therefore, could lose their jobs without a clear and balanced process. Besides, there were no unions or associations that helped them with employment disputes. Uber drivers said,

"Uber drivers have no rights, and no one looks at this. It is like you have a zero-hour contract, you can be sacked or locked out of the system anytime, and you cannot do anything about it" (D1/S3).

"… there are many cases of drivers being sacked for no reason or unsubstantiated complaints from the customer. The car doesn't have any camera on the inside, so it is hard to prove yourself innocent if one customer makes a complaint…" (D8/S3).

"There are no unions or anyone else that you can complain to if you have an issue. You cannot even call Uber; any communication is through the App or email…" (D9/S3).

Uberpool operational challenges

The participants were asked if there has been any issue arising from Uberpool operations since it was launched in London to explore the operational implications of Uberpool. The focus participants clarified that most of the operational issues related to customers' safety, especially during night-time, when many are intoxicated, and conflicts between different passengers arise. They also reported that some passengers do not like when the driver has to take longer to collect or drop-off the other sharers, which sometimes leads to drivers getting a lower rating in the Uber App.

"… the repercussions and the safety of the passengers, you have two strangers who are drunk. If you got a woman and male, they don't know each other, and they are both drunk, if anything improper happens during the journey, the driver is a witness to a problem…" (D1/S1).

"… loads of safety issues. Once I had two drunken people in the car who had two contrasting opinions, and they started arguing. Sometimes passengers were fighting in the car and dragging the other pooler out of the vehicle…" (D10/S1).

"… many customers complain and get angry when you have to divert from route to collect the second sharer, and it puts the driver in a difficult situation…" (D9/S3).

"… there are also other issues if one passenger wants the heater or music on and the other one does not, and some would ask for a mobile charger, then the other passenger also wants to use the mobile charger. So, the drivers have to try and satisfy all customers because they will rate you after the trip, so it is difficult…" (D10/S3).

The obligation to accept Uberpool Requests.

To further understand the implications of refusing an Uberpool request, the participants were asked If Uber drivers were obliged to accept all Uberpool requests and what the consequences were if they did not respond to an Uberpool trip request. The participants explained that the Uber system allowed them to skip three requests before logging them off the system for two mins at a time. Moreover, drivers who consistently reject or avoid an Uberpool request get a low trip acceptance rate, which, if it gets very low, could result in a written notice or warning from Uber to the driver. The expectation is when drivers switch on the Uber App, that they are ready for work and therefore should accept all ride requests that are routed to them.

> "… it works out a percentage of acceptance, so if you reject too many jobs and you cancel too many jobs, they will log you out of the system for two minutes. When you go back to the platform and sign in again, you can do it but what happens is they will contact you through text message saying that you are not ready to accept jobs; please, if you are not willing to accept jobs, log yourself off, or they will tell you it is bad for business because you are refusing to accept jobs so it will impact on the company…" (D1/S1).

> "… you are not forced to accept an Uberpool request, but if you continue to ignore UberX or Uberpool requests, then your 'acceptance rate' goes down. If you ignore three consecutive requests, you get blocked out of the system for two minutes. So, you must maintain high ratings all the time; otherwise, Uber will cancel your contract" (D7/S3).

Further comments and insights from the Uber drivers.

The Uber drivers said they enjoyed the flexibility of working with Uber, which allowed them to combine their work with other family or social responsibilities. However, they disliked accepting Uberpool requests and tried avoiding it as much as possible before the Uber driver app (system) blocks them out for a few minutes. Many drivers have managed to secure an exemption from Uber, which allows them not to pick up Uberpool trips. This seems to be limited to the drivers who joined Uber early, who also benefit from paying less commission to Uber (i.e., 20% for standard UberX instead of 25% per trip).

Uber drivers generally receive good feedback from passengers about the services they provide, including some users stating that they never used any kind of taxi before Uber became available in London. However, the drivers indicated a lack of guidance or training for the drivers on how to deal with problematic situations between different Uberpool customers, especially about harassment or health and safety situations, which the drivers were not always equipped to deal with.

The Uber drivers also mentioned that Uber regularly changes the fare structure, and they felt the base fare of £1.25 /mile or £0.25/minute, and trips to/from the airport were too low considering the commission they pay to Uber, and as a result, they sometimes struggled to make their daily or weekly targets.

Furthermore, the participants raised various concerns regarding the lack of control of Uber drivers in London, which some participant thought was getting out of control and significantly affecting how much they make per day. Also, there were worries about Uber's impacts, such as congestion and pollution, if the drivers and vehicles are not managed carefully in the future.

Broadly, the drivers thought that Uber is making an outstanding contribution to the city and society in general, including job creation for many Londoners, numerous complementary businesses including car rentals and sales, car wash centres, insurance companies (Uber drivers need special PHV insurance) and tyre shops. However, drivers' rights and welfare remain a big concern.

A review of the participants' responses relating to operational challenges, dealings with TfL and driver welfare issues indicates that drivers generally felt that they do not usually get heard, and their views are not considered when discussing ridesourcing related issues. As such, some of the feedback discussed in this theme may have been overstated by participants in order to get their side of the story out by highlighting what they consider as the main challenges. Particularly regarding regulatory and operational encounters with TfL and driver welfare and general operational implications whilst also underlining the perceived benefits brought about by Uber and ridesourcing in general, based on the participants' personal experiences. For instance, where they have offered their services, issues they have faced while on duty or personal interests, such as improving their job conditions.

Therefore, as ridesourcing services evolve in London, Uber and the transport regulators need to consider the issues and concerns raised by the Uber drivers in order to prevent health and safety issues for both customers and drivers; manage driver welfare problems and reduce any long-term negative consequences of shared ridesourcing services.

6.2 Chapter Summary

This chapter presented the qualitative data analysis results for the focus group sessions with Uber drivers in London.

Focus groups were conducted with 28 London Uber drivers to help answer key research questions including, how Uberpool services were used and what attracts people to use Uberpool in London. Accordingly, the findings concerning how Uberpool services are used, the user characteristics, and the reasons travellers in London choose the service were explained, which were essential elements of the research. Furthermore, the emerging Uber driver welfare and operational consequences are discussed.

The results revealed that one of the Uber business model's key benefits was the number of jobs it has created and the ease of use and flexibility it offers to the drivers. However, there was an obvious need for a joint approach regarding driver welfare (i.e., working hours and unions) and how the service should be regulated (i.e., number of drivers) to overcome the general apprehension about the transport authorities and regulators.

The findings showed travellers used Uberpool because it was convenient, especially at night / during late hours; easy to request and pay for the service using the mobile app and the cheaper trip cost compared to other modes (i.e., UberX, PT, conventional minicab, and black taxi Services). Uber drivers indicated that cost-sensitive travellers often opt for Uberpool to reduce trip cost, mainly when the surge price is active and the cost of using standard UberX significantly increases. Uberpool was mainly used during the night, weekends, and early mornings, and the primary trip purpose was to go home after a night out, for longer journeys or to/from university or college. The most prominent Uberpool users included students and those making social trips such as a night out in the city, and the service was popular in central London and south London areas, where PT access was limited. Additionally, Uber drivers reported that many travellers use Uberpool to socialise during trips and, sometimes, to find a date, which appears to be an additional motive for adopting shared ridesourcing.

The main competitors to Uberpool in central London were black cabs and PT services, particularly the 24hr tube services, except in South London areas where black cabs did not go often and had limited or no tube services. Moreover, the Uber drivers explained that, from their perspective, Uber services in general and Uberpool specifically were not affecting PT services negatively. However, it provided a complementary service that connected travellers to PT stops and stations (i.e., areas with limited or no tube service) or catered for travel demand during special events or train/tube strikes or late at night.

The findings also indicated that approximately 20 to 30 percentage of the daily Uber requests per driver were commonly Uberpool trips, and it was approximately 15% to 25%, cheaper than UberX. However, drivers disliked taking Uberpool trips, mainly because of the commission they pay and the time it takes to complete several shared trips. The significant issue that the drivers perceived was that of safety, most notably intoxicated mixed groups of travellers.

The findings in this chapter helped answer the research questions and provide insights from Uber drivers' perspectives, which is vital for policymakers and regulators to understand all the concerns from an important stakeholder, the drivers.

The next chapter will provide the quantitative data analysis results that use survey data from UberX and Uberpool users in London.

Chapter 7: Uber user survey results

7.1 Introduction

The quantitative data for this study was analysed based on the approaches detailed in Chapter Three of this thesis. The Uberpool and UberX user survey data analysis included statistical analysis, which consisted of descriptive analysis, cross-tabulation, and Chi-square tests of key dependent and independent variables. Moreover, a number of Categorical Regression (CATREG) models were developed to further investigate the key factors that affect the use of Uberpool services and why travellers use them.

This chapter presents the findings from both the statistical (descriptive) analysis and CATREG modelling. It presents empirical data on why travellers choose Uberpool instead of other modes such as PT and how Uberpool services affect car ownership, single-occupancy car trips and other modes. Moreover, it highlights the most significant variables and influencing factors that affect how Uberpool services are being used and why. It then concludes with a summary of the chapter.

7.2 Uberpool and UberX User Survey: Comparison between Uberpool and UberX

Introduction

The survey included detailed (objective and attitudinal) questions that dealt with different aspects of the service that the passengers were using. There was a total of 907 (450 UberX and 457 Uberpool) completed survey forms that were received and analysed.

The Uberpool and UberX user survey data were initially analysed using descriptive statistical methods to measure the frequencies, means, and variations of the collected survey data. The aim was to investigate how and why travellers were using Uberpool and UberX services in London and thus understand the usage and user characteristics of both services and find correlations between different variables and responses from the survey.

A summary of the socio-demographic profiles of Uberpool and UberX users is provided in Table 7, Chapter Three. Therefore, this section provides a summary of the results for the main dependent and independent variables, including important empirical data that corresponds to who the users of UberX and Uberpool are (i.e., socio-demographics), how frequently the services were used, what the trip purposes were, when the services were used and why, and the effects on car ownership and single-occupancy car trips.

7.2.1 How are Uberpool and UberX services currently used

Who uses Uberpool & UberX services in London?

UberX and Uberpool users were asked to report if they were residents or visiting London, and the majority of UberX (89.8%) and Uberpool (90.5%) users reported they were London residents. Additionally, the majority of UberX (79.4%) and Uberpool (77.4%) users said they were employed/self-employed, and a smaller percentage of users reported they were students, 15.8% (UberX) and 14.9% (Uberpool). Furthermore, the majority (67.5%) of UberX users reported they were between the ages of 18-35 compared to 51.5% of Uberpool users for the same age group. A Chi-square test was conducted to compare UberX and Uberpool users' responses, which shows a statistically significant difference between users' responses. UberX users were more likely to be younger than Uberpool users. More UberX users fell in the 18-25, 26-30 and 31-35 age groups than Uberpool users. In contrast, a higher percentage of Uberpool users were found in the 36-40, 41-45, 46-50, 51-55, and 56 (or over) age groups. Both UberX and Uberpool users had a similar gender split of 49% female and 50% male.

When asked to report their highest level of education, the majority of UberX (92.6%) and Uberpool (89.5%) reported they had completed at least an undergraduate/college education. Moreover, 32% (UberX) and 28% (Uberpool) of users stated they had a postgraduate degree compared to 2.5% (UberX) and 3.8% (Uberpool) of users who said they had only primary education or no education. A Chi-square test was conducted to compare UberX and Uberpool users' responses regarding the highest education levels, and results showed statistically significant differences between users' responses.

Furthermore, the results showed that the majority of UberX and Uberpool users in London have a driving license (74.2%, UberX; 72.6% Uberpool). Most users reported having a driving license, although just over half (51.8%) of UberX and over three quarters

(76.9%) of Uberpool users reported currently not owning a car. Furthermore, the majority of Uberpool respondents (67.5%) and (35.1%) of UberX respondents reported not owning a car before they started using Uber services. The vast majority of UberX and Uberpool users also reported owning an Oyster/Travelcard for PT (89.4%, 93.5%, respectively), indicating high PT usage.

A Chi-square test was used to analyse the relationships between the two different Uber services and the different socio-demographic features for UberX and Uberpool users, as detailed in Table 13. The results show that age, education level, owning an Oyster/Travelcard, and car ownership (before Uber and at present) were all statistically significant.

The findings indicated that the socio-demographic characteristics of survey respondents were diverse; however, the representativeness of the sample for the whole Uber user population was difficult to verify because there were no previous Uber or ridesourcing user data. Accordingly, the findings were considered valid for user population with the same socio-demographic characteristics.

Table 13. UberX and Uberpool Users socio-demographics: Chi - Square results

Socio-demographic Variables	***Chi-square***	***Sig.***	***Key differences***
Hold a driving license	0.297	0.586	-
Car owner at present	49.283	< 0.001	*Less Uberpool users own a car*
Car owner before starting using Uber services	36.155	< 0.001	*More UberX users owned a car*
Owner of Oyster / Travel card for PT	4.777	0.029	*Less UberX users hold Oyster/PT card*
Visitor or Resident of London	0.115	0.735	-
Employment status	3.929	0.269	-
Age group	29.597	< 0.001	*Younger UberX users*
Gender	3.949	0.139	-
Highest level of education completed	12.084	0.034	*More UberX users hold postgrad.*

How frequently are Uberpool and UberX services used

UberX and Uberpool users were asked how often they used the Uber services, in general. For UberX users, the top responses were “2-4 times a week” (27%) and “once or twice a month” (21%). For Uberpool users, the top responses were “2-4 times a week” (31%) and “once or twice a week” (27%), indicating that over half of Uberpool users typically use the service weekly, as detailed in Table 14.

A Chi-square difference test was conducted to compare the categorical responses from UberX and Uberpool users, and the results indicated a statistically significant difference between UberX and Uberpool users' responses. UberX users were more likely to use the service more than once a day (13% Vs 9%). However, Uberpool users were more likely to have higher usage throughout the week (57% Vs 45%). The results showed a higher number of users (21%), indicating they used UberX "once or twice a month" compared to Uberpool users (8%). A probable reason for the difference might be that users who usually use PT or own a car (more UberX users said they owned a car) occasionally go out to the city at night (one of the primary trip purposes) using UberX.

Table 14. How often are UberX and Uberpool services used, in general

Responses	**UberX (*n* [2]= 447)**		**Uberpool (*n* = 454)**	
	Frequency	Percentage	Frequency	Percentage
Twice or more daily	57	13%	39	9%
At least once a day	28	6%	55	12%
2-4 times a week	120	27%	139	31%
Once or twice a week	82	18%	121	27%
Less than once a week	30	7%	33	7%
Once or twice a month	92	21%	37	8%
Less than once a month	12	3%	13	3%
Occasionally (i.e., 2-3 times a year)	20	5%	12	3%
Other	6	1%	5	1%
UberX vs. Uberpool		$\chi2$ (df)	*P*-Value	Significant
		46.72	.000	Yes

A Chi-square test was utilised to analyse the relationships between service type and frequency of use and the results show a statistically significant difference for the two service types.

To further understand how often the services were being used, UberX and Uberpool users were asked to indicate: "how often they had used Uber services in the last month". UberX users' responses ranged from 0 to 100 uses in the last month, while Uberpool responses were between 0 and 50 uses. An independent t-test was utilised to determine if the two service types are statistically different based on their frequency of use in the

[2] The 'N' value shown represents the total number of valid responses received for that specific survey question and not the total sample size.

last month. An independent t-test is performed because this was a continuous variable, ranging from 0 to 100 (i.e., the maximum observed in the responses) in the dataset. The results showed no statistical significance ($p = 0.46$, which is more than the critical value of 0.05). The mean of the frequency of use in the last month for Uberpool (mean= 9.07) is not deemed statistically different from that of UberX (mean= 8.65). From these results, it is concluded that on average, each month, travellers use both services at similar levels.

UberX and Uberpool users were asked how long they had used the services (i.e., when they first began using the Uber services, which they were using at the time of the survey). The vast majority of UberX users indicated that they have been using services "for more than six months" (63.7%), compared to slightly under half of the Uberpool users (46.0%). It is worth noting that the UberX service was available in the city much longer. To compare the differences in UberX and Uberpool users' responses, a Chi-square difference test was conducted, and the results (P-Value = 0.000) indicated that there were statistically significant differences.

To understand more about how Uberpool and UberX are currently used in London, the Uber users were asked about the "modes of transport they used the most in London". Response options were provided in a Likert scale format where 1= Never to 5 = Always. The majority of UberX users reported that they "often" or "always" used PT (69.7%) or walked (58.0%) as ways to get around London. Moreover, Uberpool users also reported that they "often" or "always" used PT (84.1%), walked (79.4%), or used ridesourcing (69.8%) to get around London, as detailed in Table 15. To compare UberX and Uberpool users' responses, a One-way ANOVA test was conducted, and the results indicated that there were several statistically significant differences in responses. Compared to UberX users, Uberpool users were more likely to report that they never drove personal cars (48.4% Vs 35.6%). They were also more likely to report that they often used ridesourcing (53.8% Vs 37.8%).

Table 15. Modes of transport used the most in London (Descriptive Analysis Results)

Mode of Transport Used the Most	UberX		Uberpool		UberX Vs Uberpool
	Freq.	%	Freq.	%	*p*-value
Personal Car – As Driver	***n* = 432**		***n* = 450**		
Never	154	35.6%	218	48.4%	
Rarely	98	22.7%	131	29.1%	
Sometimes	74	17.1%	37	8.2%	
Often	33	7.3%	28	6.2%	
Always	73	16.2%	36	8.0%	*0.000*
Personal Car – As Passenger	***n* = 431**		***n* = 451**		
Never	66	14.7%	19	4.2%	
Rarely	84	19.5%	51	11.3%	
Sometimes	172	39.9%	289	64.1%	
Often	95	22.0%	81	18.0%	
Always	14	3.2%	11	2.4%	*0.000*
Car Clubs	***n* = 422**		***n* = 446**		
Never	207	49.1%	222	49.8%	
Rarely	89	21.1%	122	27.4%	
Sometimes	106	25.1%	76	17.0%	
Often	16	3.8%	18	4.0%	
Always	4	0.9%	8	1.8%	*0.385*
Ridesourcing	***n* = 429**		***n* = 450**		
Never	16	3.7%	9	2.0%	
Rarely	45	10.5%	11	2.4%	
Sometimes	168	39.2%	116	25.8%	
Often	162	37.8%	242	53.8%	
Always	38	8.9%	72	16.0%	*0.000*
Public Transport	***n* = 441**		***n* = 454**		
Never	11	2.5%	5	1.1%	
Rarely	19	4.3%	12	2.6%	
Sometimes	104	23.6%	55	12.1%	
Often	189	42.9%	194	42.7%	
Always	118	26.8%	188	41.1%	*0.000*
Taxi	***n* = 432**		***n* = 451**		
Never	82	19.0%	117	25.9%	
Rarely	158	36.6%	172	38.1%	
Sometimes	121	28.0%	82	18.2%	
Often	60	13.9%	67	14.9%	
Always	11	2.5%	13	2.9%	*0.054*
Cycle	***n* = 422**		***n* = 444**		
Never	157	37.2%	139	31.3%	
Rarely	115	27.3%	149	33.6%	
Sometimes	85	20.1%	83	18.7%	
Often	46	10.9%	54	12.2%	
Always	19	4.5%	19	4.3%	*0.425*
Walk	***n* = 433**		***n* = 451**		
Never	37	8.5%	27	6.0%	
Rarely	47	10.9%	20	4.4%	
Sometimes	98	22.6%	46	10.2%	
Often	160	37.0%	176	39.0%	
Always	91	21.0%	182	40.4%	*0.000*

Cross-tabulations was undertaken between key variables (i.e., survey questions) such as ‘modes normally used in London’ and ‘Frequency of Uberpool usage’ as detailed in Appendix C. Moreover, a Chi-square test was utilised to analyse the relationships between the variables.

The Results show that for Uberpool, there are a larger proportion of respondents who are frequent users at “night” and “during public holidays” who also frequently “use their car – as a driver” in London. Whilst there are a larger proportion of respondents who are frequent users “during weekends”, “weekdays (Mon-Fri)”, and “during public holidays” who also frequently “use a car – as a passenger” to get around London. However, there are a higher proportion of respondents who are frequent users during “public holidays” who are also frequent users of “car clubs” in London. Nevertheless, there are a higher proportion of respondents who are frequent users at “night”, “during weekends”, “during weekdays (Mon-Fri)”, and “during weekdays (early morning/late evening)”, who are also frequent users of “ridesourcing”.

When are UberX and Uberpool services used?

UberX and Uberpool users were asked how frequently they used the service during different days and times, using a Likert-scale question. Possible responses were “never”, “rarely”, “sometimes”, “often” or “always”. Approximately half of the UberX users indicated that they “often” or “always” used Uber services at night (50.7%) and during weekends (48.0%). Similarly, Uberpool users reported similar usage frequencies, with over half (56.4%) of Uberpool users indicating they used the services at night and nearly half (48.4%) reporting they used the services during the weekend, as shown in Table 16. However, 45.3% (UberX) and 43.5% (Uberpool) of users said they “sometimes” used the service weekdays (early morning/late nights), whereas 17.9% (UberX) and 23.4% (Uberpool) of users stated they “never” used the service during public holidays.

Table 16. Frequency of usage – Uberpool and UberX

Freq. of Use During.	**UberX**		**Uberpool**		UberX Vs Uberpool
	Freq.	*Percentage*	*Freq.*	*Percentage*	*p-value*
1. At Night *(8pm-5am)*	*n = 433*	*n = 455*			
Never	19	4.4%%	21	4.6%	
Rarely	31	7.2%	21	4.6%	
Sometimes	163	37.6%	156	34.3%	
Often	124	28.6%	179	39.3%	
Always	96	22.2%	78	17.1%	
					0.738
2. During Weekends	*n = 425*		*n = 451*		
Never	17	4.0%	13	2.9%	
Rarely	37	8.7%	25	5.5%	
Sometimes	167	39.3%	195	43.2%	
Often	172	40.5%	187	41.5%	
Always	32	7.5%	31	6.9%	
					0.411
3. During Weekdays: *AM (5am-9am) Or Evening (6-9pm)*	*n = 424*		*n = 453*		
Never	34	8.0%	29	6.4%	
Rarely	92	21.7%	108	23.8%	
Sometimes	192	45.3%	197	43.5%	
Often	77	18.2%	98	21.6%	
Always	29	6.8%	21	4.6%	*0.893*
4. During Weekdays: *Mon – Fri 9am-5pm*	*n = 421*		*n = 451*		
Never	48	11.4%	49	10.9%	
Rarely	123	29.2%	156	34.6%	
Sometimes	148	35.2%	154	34.1%	
Often	68	16.2%	78	17.3%	
Always	34	8.1%	14	3.1%	
					0.071
5. Public Holidays	*n = 420*		*n = 449*		
Never	75	17.9%	105	23.4%	
Rarely	117	27.9%	184	41.0%	
Sometimes	139	33.1%	108	24.1%	
Often	60	14.3%	36	8.0%	
Always	29	6.9%	16	3.6%	
					0.000

A Chi-square test was performed to compare UberX and Uberpool users' responses for each response category of frequency of usage and the results indicated no statistically significant differences between responses except for usage during public holidays (χ2 (df) = 26.18; P-Value = 0.000).

To further investigate the relationships between the variables of "modes used normally to get around London" and "frequency of Uberpool usage", a cross-tabulation analysis was conducted. The results show that for Uberpool, there are a larger proportion of respondents who are frequent users at “night” and “during public holidays” who are also frequent users of “using their personal car – as a driver” to get around London as shown in Table 17. Moreover, there were more proportion of respondents who are frequent users at “night”, “during weekends”, “during weekdays (Mon-Fri)”, who are “not” frequent users of PT in London, which indicates that these users relied on none-PT modes such as ridesourcing for getting around London, particularly at night.

Table 17 Cross-tabulation results for frequency of using Uberpool and the modes used normally totravel in London

		Frequency of (Uberpool) use during:				
Modes used normally to get around London		(A) - at night (8pm - 5am)	(B) - During weekends	(C) - Week days: Early morning/ late evening	(D) - Week days (Mon - Fri)	(E) - Public holidays.
Personal Car - as a driver	Chi-square	4.14	2.07	0.79	0.09	8.32
	Sig.	0.04	0.15	0.38	0.77	0.00
Car as Passenger	Chi-square	0.87	7.38	0.46	4.41	21.51
	Sig.	0.35	0.01	0.50	0.04	0.00
Car-clubs *(e.g., Zip car)*	Chi-square	0.26	1.42	0.96	1.92	10.33
	Sig.	0.61	0.23	0.33	0.17	0.00
Ridesourcing *(e.g., Uber)*	Chi-square	28.55	24.10	22.22	14.88	1.42
	Sig.	0.00	0.00	0.00	0.00	0.23
Public Transport *(Bus/Tube/Train)*	Chi-square	0.01	0.11	3.63	0.53	6.14
	Sig.	0.92	0.74	0.06	0.46	0.01
Taxi *(i.e., minicab or black cab)*	Chi-square	0.16	0.40	0.34	0.67	2.18
	Sig.	0.69	0.52	0.56	0.41	0.14
Cycle	Chi-square	0.50	1.03	0.06	0.15	3.30
	Sig.	0.48	0.31	0.81	0.70	0.07
Walk	Chi-square	0.05	0.15	0.07	0.03	0.38
	Sig.	0.82	0.70	0.80	0.87	0.54

What Trip Purposes are used for Uberpool and UberX

To understand more about the types of trips that were being made using Uber services, the users of UberX and Uberpool were asked to report the purpose of their trip when they were completing the survey. For UberX users, the top responses were “going home” (29.4%), “going to school or work” (25.2%), and “social event” (13.6%), while for Uberpool users, the top responses were “going to school or work” (29.5%), “going to PT station/stop” (20.4%), and “going home” (16.6%) as detailed in Table 18.

A Chi-square difference test was used to compare the differences between UberX and Uberpool users' responses, and the results indicated that there were statistically significant differences in the two services users' trip purposes. UberX users were more likely to report that the purpose of their journey was to "go home", "visit family/friends", and go to the "airport." However, Uberpool users were more likely to report "going to school/work", "going to PT stop/station", going to a "social event", and running "errands/shopping" as the purpose for their trip.

Table 18: Trip purpose and trip origin for UberX and Uberpool

Trip Purpose (Destination)	**Uberpool** (*n* = 457)		**UberX** (*n* = 449)	
	Freq.	**%**	**Freq.**	**%**
Doing family errands (i.e., GP)	21	5%	16	4%
Going Home	76	17%	132	29%
Going Shopping	26	6%	12	3%
Going to Airport	13	3%	35	8%
Going to Public Transport station (i.e., Bus, Train, Tram, Tube)	93	20%	11	2%
Going to School/College/University	13	3%	14	3%
Going to social event/activity	65	14%	61	14%
Going to work	122	27%	99	22%
Visiting family/friends	26	6%	57	13%
Other	2	0%	12	3%
		χ2 (df)	Significant	
UberX Vs. Uberpool		115.37	Yes	
Trip origin	**Freq.**	**%**	**Freq.**	**%**
Airport	1	0%	15	3%
home	206	45%	225	50%
At social event/activity (i.e., gym, bar etc.)	89	19%	73	16%
Family or friends place	63	14%	44	10%
Office/workplace	23	5%	44	10%
Other	6	1%	6	1%
Other (Hospital)	2	0%	3	1%
Other (Hotel)	11	2%	8	2%
Other (Shopping)	2	0%	4	1%
Public Transport station	54	12%	26	6%
		χ2 (df)	Significant	
UberX Vs. Uberpool		34.34	Yes	

The Chi-square test results showed that both variables of "trip purpose" and "trip origin" were statistically significant for both Uber services.

Additionally, UberX and Uberpool users were asked to report the origin of their current trip and almost half of Uberpool users reported: "home" (45.1%), "from social event/activity" (19.5%), and "family/friend's place" (13.8%) as their trip origin. Of the Uberpool users who began their trip at home, the highest percentage of users reported that they were going to school/work (45%), while 11% said they were going to a public PT station/stop. Moreover, the highest percentage of those who began their journey at a social event reported that they were going home (54.5%).

Similarly, half of the UberX users stated: "home" (50.2%) as their trip origin, while the subsequent most common responses were "from social event/activity" (16.3%), "family/friend's place" (9.8%), and "office/workplace" (9.8%).

A Chi-square difference test was conducted to compare the differences between UberX and Uberpool users' responses, and the results show that there were statistically significant differences between UberX and Uberpool users' reported trip origins.

A cross-tabulation analysis of the "trip origin" and "trip purpose (Destination)" was undertaken, and an Origin-Destination (O-D) matrix was developed for both services as detailed in Table 19. The results indicate that many Uberpool users used the service to go from the trip origin to reach a PT station or stop.

Table 19. O-D Matrix for UberX and Uberpool journeys

UberX *(n =418)*

Trip Origin	Going Home	Errands/ Shopping	Airport	PT Station /Stop	Education/ Work	Social Event or Activity	Visit friends /family
	Trip Purpose						
Airport	10	0	2	0	1	1	0
Home	12	19	23	6	93	34	34
Social Event	51	3	0	0	2	12	3
Family/Friends Place	18	3	5	0	5	6	6
Workplace	22	1	1	4	9	3	4
PT station/Stop	11	1	0	1	3	1	8

Uberpool *(n =434)*

Trip Origin	Going Home	Errands/ Shopping	Airport	PT Station /stop	Education/ Work	Social Event or Activity	Visit friends /family
	Trip Purpose						
Airport	0	0	1	0	0	0	0
Home	4	34	6	23	92	34	12
Social Event	48	1	0	29	3	6	1
Family/Friends Place	11	7	2	19	1	21	2
Workplace	5	2	0	12	3	0	1
PT Station/Stop	5	1	4	0	34	3	7

In order to understand how travellers generally use the UberX and Uberpool services in London and not just for that specific trip, the users were also asked to indicate “what type of trips they normally used the service for”. For each category, users responded "Yes" or "No" to indicate whether the category represented their usual trip purpose. For UberX users, the top responses were "to/from social events/activities" (59.3%), "visiting family/friends" (39.3%), and "to/from work" (34.4%). Uberpool users’ top responses were “to/from social events/activities” (83.2%), “visiting family/friends” (64.1%), and “to/from PT station/stop” (37.0%) as detailed in Table 20. A Chi-square test used to compare UberX and Uberpool users' responses, and the results show that there are statistically significant differences in users' normal trip types, except for going "to/from work and shopping".

Table 20. Trip Types normally used for Uberpool and UberX Services

Trip Type *(normal usage)*	**UberX (*n* = 450)**		**Uberpool (*n* = 457)**		**UberX Vs. Uberpool**
	Freq.	**Percentage**	**Freq.**	**Percentage**	*P-Value*
To/From Social Activities	267	59.3%	380	83.2%	0.000
Visit Friends/Family	177	39.3%	293	64.1%	0.000
To/From Work	155	34.4%	130	28.4%	0.052
To/From PT Station	55	12.2%	169	37.0%	0.000
To/From Airport	133	29.6%	73	16.0%	0.000
To/From Shopping	68	15.1%	80	17.5%	0.329
To/From School	28	6.2%	48	10.5%	0.020
Other	17	3.6%	6	1.3%	

Transport modes used for the same/similar trips before Uber

Users of UberX and Uberpool were asked to report the 'modes of transport they used before they started using Uber for the same/similar trips' in order to understand the potential impacts of Uber services on other modes. The top responses from both UberX and Uberpool users showed they used "Tube/Train/Tram" and "PT bus" with 54.3% of UberX users and 60% of Uberpool users indicating that they used PT services for the same or similar trips before Uber as detailed in Figure 5. Furthermore, results show that UberX users were more likely to drive a car alone before Uber started in London, besides a small percentage of users indicated they did not make the same trip before. A Chi-square difference test was used to compare the categorical responses for each type of mode, and the results showed statistically significant differences for "tube/train/tram" ($\chi2$ (df) = 32.26; P-Value = 0.001), "PT bus" ($\chi2$ (df) = 52.47; P-Value = 0.003), "driver a car alone" ($\chi2$ (df) = 18.05; P-Value = 0.000) and "walk" ($\chi2$ (df) = 40.52; P-Value = 0.000), modes. Also, Chi-square difference test were run for all the modes and the results ($\chi2$ (df) = 23.62; P-Value = 0.005) showed statistically significant differences in UberX and Uberpool users' responses.

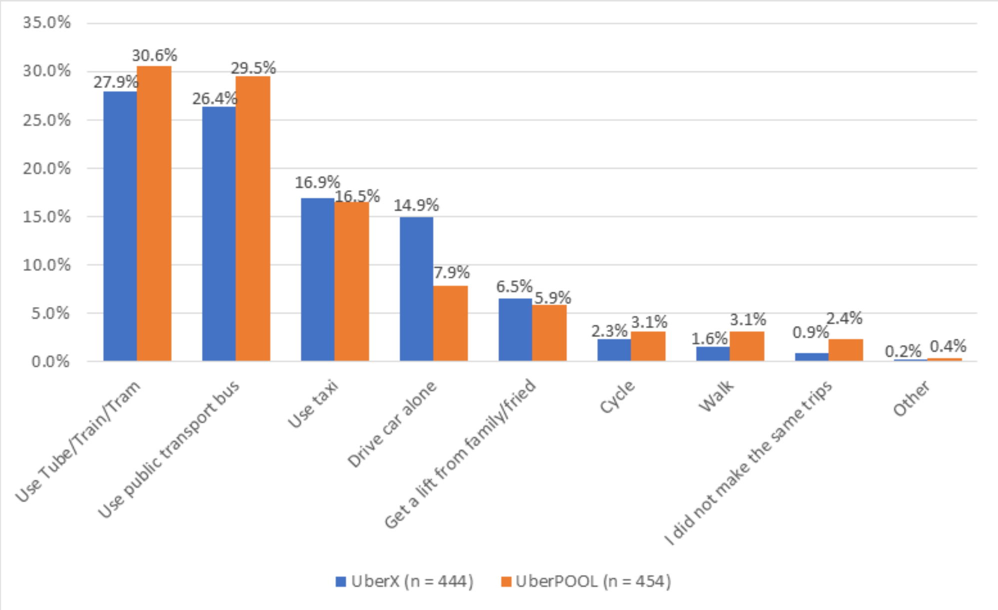

Figure 5. Transport mode used the most before Uber, for same/similar trip

If Uber services were not available, what other transport mode would most likely be used for the same trip

To further investigate the level of impact on traditional PT modes from Uber services, the users of UberX and Uberpool were asked: "the transport mode they would have used for the same trip if Uber were not available". The results show that the majority of UberX users reported that they would "always" or "most likely" use a "Train/Tube/Tram" or a "PT Bus" as detailed in Table 21, which indicates many UberX trips are replacing traditional PT trips. However, the majority of Uberpool users reported that they would "always" or "most likely" use "other ridesourcing services", "Train/Tube/Tram", or "PT bus". The results for both Uber services underline the link between PT trips and Uber usage, although Uberpool users indicated that "other ridesourcing" services would be their primary preference if Uberpool were not available. A one-way ANOVA test was conducted to compare the mean for UberX and Uberpool users' responses, and the results showed differences in users' responses were statistically significant except for responses that said they used the train/tube/tram, PT bus, or did not make this trip. The notable differences include that Uberpool users were more likely to report they would "never use" or it was "unlikely" that they would drive a car for the same trip, while UberX users were more likely to report that they would "always" or "most likely" walk if Uber were not available for the same trip which shows the potential impact of UberX on walk trips.

Table 21. If Uber services were not available, what other transport mode would you most likely use for the same trip (Descriptive Analysis Results)

Response Options	UberX		Uberpool		UberX Vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
Drive Car Alone	***(n = 429)***		***(n = 454)***		
Never	51	11.9%	46	10.1%	
Unlikely	221	51.5%	319	70.3%	
Maybe/Neutral	23	5.4%	17	3.7%	
Likely	68	15.9%	29	6.4%	
Always	66	15.4%	43	9.5%	
Mean = 2.71 (UberX); 2.35 (Uberpool)					*0.000*
Get a lift from family/friends	***(n = 430)***		***(n = 451)***		
Never	101	23.5%	107	23.7%	
Unlikely	153	35.6%	201	44.6%	
Maybe/Neutral	65	15.1%	62	13.7%	
Likely	97	22.6%	71	15.7%	
Always	14	3.3%	10	2.2%	
Mean = 2.47(UberX); 2.28 (Uberpool)					*0.015*
Car Club	***(n = 428)***		***(n = 450)***		
Never	84	19.6%	101	22.4%	
Unlikely	221	51.6%	271	60.2%	
Maybe/Neutral	86	20.1%	48	10.7%	
Likely	31	7.2%	25	5.6%	
Always	6	1.4%	5	1.1%	
Mean = 2.19 (UberX); 2.03 (Uberpool)					*0.004*
Other ridesourcing	***(n = 418)***		***(n = 453)***		
Never	80	19.1%	17	3.8%	
Unlikely	112	26.8%	16	3.5%	
Maybe/Neutral	134	32.1%	88	19.4%	
Likely	80	19.1%	268	59.2%	
Always	12	2.9%	64	14.1%	
Mean = 2.60 (UberX); 3.76 (Uberpool)					*0.001*
Train/Tube/Tram	***(n = 433)***		***(n = 450)***		
Never	29	6.7%	39	8.7%	
Unlikely	25	5.8%	14	3.1%	
Maybe/Neutral	85	19.6%	121	26.9%	
Likely	200	46.2%	201	44.7%	
Always	94	21.7%	75	16.7%	
Mean = 3.70 (UberX); 3.58 (Uberpool)					*0.076*
Public Transport Bus	***(n = 433)***		***(n = 450)***		
Never	53	12.2%	31	6.9%	
Unlikely	27	6.2%	15	3.3%	
Maybe/Neutral	93	21.5%	133	29.6%	
Likely	178	41.1%	207	46.0%	
Always	82	18.9%	64	14.2%	
Mean = 3.70 (UberX); 3.58 (Uberpool)					*0.228*
Taxi	***(n = 426)***		***(n = 448)***		
Never	105	24.6%	116	25.9%	
Unlikely	97	22.8%	152	33.9%	
Maybe/Neutral	78	18.3%	87	19.4%	
Likely	120	28.2%	76	17.0%	
Always	26	6.1%	17	3.8%	
Mean = 2.68 (UberX); 2.39 (Uberpool)					*0.000*

Cycle	***n* = 423**		***n* = 451**		
Never	92	21.7%	98	21.7%	
Unlikely	230	54.4%	273	60.5%	
Maybe/Neutral	44	10.4%	44	9.8%	
Likely	38	9.0%	28	6.2%	
Always	19	4.5%	8	1.8%	
Mean = 2.20 (UberX); 2.06 (Uberpool)					*0.024*
Walk	***n* = 426**		***n* = 446**		
Never	66	15.5%	75	16.8%	
Unlikely	192	45.1%	280	62.8%	
Maybe/Neutral	54	12.7%	44	9.9%	
Likely	74	17.4%	35	7.8%	
Always	40	9.4%	12	2.7%	
Mean = 2.60 (UberX); 2.17 (Uberpool)					0.000
Not make this trip	***n* = 426**		***n* = 426**		
Never	71	18.2%	29	6.5%	
Unlikely	248	63.6%	358	80.6%	
Maybe/Neutral	47	12.1%	33	7.4%	
Likely	20	5.1%	21	4.7%	
Always	4	1.0%	3	0.7%	
Mean = 2.07 (UberX); 2.12 (Uberpool)					0.278

A Chi-square test was used to analyse the relationships between the Uber service types and the four key variables of "trip purpose", "trip origin", "mode used before Uber" and "average fare savings" to understand if they were statistically significant. The variable of "average Uberpool fare savings" was included as an important variable because 57.1% of Uberpool users indicated they chose the service because they made a fare saving of 11% to 30% by opting for Uberpool instead of UberX as detailed in section 7.2.2. The results show that all the variables were statistically significant, as presented in Table 22.

Table 22. Chi-square test significance results for UberX and Uberpool Against four key variables

Variables	***Chi-Square***	***Significance***
Transport mode used before Uber Vs Trip Purpose - UberX	72.50	< 0.001
Transport mode used before Uber Vs Trip Purpose - Uberpool	50.71	< 0.001
Average Uberpool Fare Savings Vs Trip Purpose - Uberpool	25.42	0.005
Trip Origin/Start Vs Trip Purpose - Uberpool	189.38	< 0.001

Effect on Car Ownership and Single-occupancy Car Trips

To understand the potential impact of ridesourcing services on car ownership, UberX and Uberpool users were asked if they currently owned a car, if they owned a car before starting to use Uber services and what effect the availability of Uber had on whether or not they owned a car.

The results show that most users had a driving license (UberX, 74.2% and Uberpool, 72.6%) and that more than half (54.7%) of UberX users and 32.5% of Uberpool users owned a car before using Uber services, but 67.5% of Uberpool users said they did not own a car even before Uber services became available. In contrast, approximately half (51.8%) of UberX users and the vast majority (76.9%) of Uberpool users said they did not currently own a car compared to 48% of UberX user and 23% of Uberpool users who said they owned a car at present. Accordingly, the results show that UberX users were more likely to be car owners (before Uber and at present) who use the service for a specific trip purpose (i.e., social trips).

There was a 6.5% decrease in car ownership for UberX users and a 9.4% decrease in car ownership for Uberpool users, indicating that Uberpool could be having a more considerable influence on car ownership, similar to findings related to carsharing by Martin & Shaheen (2011) and for ridesourcing by Bekka et al. (2020). To further understand this, UberX and Uberpool users were also asked to indicate the level of influence that Uber had on their car ownership decisions, and 45% of UberX users and 38.4% of Uberpool users said the availability of Uber had "some or very high effect". However, 31.2% of UberX users and 37.3% of Uberpool users stated that it had 'very little or no effect'. The results indicate that Uber could be an important factor in the respondent's likelihood to own a car or not.

To understand whether Uberpool is helping to reduce single-occupancy car trips, Uberpool users were asked how many other Uberpool users were travelling during the trip when the survey was completed. The data was analysed, and the results show that 53% of Uberpool users stated that there was one other Uberpool passenger, and 19% stated there were two or more other Uberpool passengers with them in the same car, which indicates the potential of Uberpool services to help reduce single-occupancy car trips.

Section Summary

This section summarised the main results from the descriptive statistical analysis, including how and when Uberpool and UberX services were being used, the frequency of usage and the primary trip purposes. Moreover, key findings are offered concerning the transport modes which travellers used for the same or similar trips before Uber and the possible effects on car ownership and single-occupancy car trips.

The findings revealed that most Uberpool and UberX users in London were employed/self-employed, with around 15% being students. Most users had completed at least an undergraduate/college education (UberX; 92.6% and Uberpool; 89.5%).

Furthermore, over half of Uberpool users indicated using the service weekly, including 31% who used it "2-4 times a week" and 27% who used it "once or twice a week". On average, Uberpool users reported using the service 9.07 times in the last month. Additionally, to get around London, Uberpool users "often" or "always" used PT (84.1%), walked (79.4%), or used ridesourcing (69.8%).

Approximately half of the Uberpool users (56.4%) always used the service at night, while 48.4% used it during the weekend. However, nearly half used it 'sometimes' during weekdays (early morning/late nights). Moreover, the primary trip purposes for Uberpool users were found to be going to "work or college/school", "PT station/stop", or "home".

The results also revealed that 60% of Uberpool and 54.4% of UberX users utilised PT modes (i.e., Tube, Train, Tram or Bus) for the same or similar trips before they started using Uber. Moreover, the findings showed a 6.5% decrease in car ownership for UberX users and a 9.4% for Uberpool users, indicating the level of influence that Uber might have on car ownership.

These findings provide relevant and useful empirical data and new insights about ridesourcing services, how they are used, the user characteristics and frequency of use, which add to the current body of knowledge on the topic.

7.2.2 What attracts people to use Uberpool

Why people use Uberpool, instead of UberX and traditional taxi

The socio-demographic characteristics of the Uberpool survey respondents were varied, as outlined in subsection 7.2.1 of this thesis. However, it was impossible to verify the representativeness of the survey sample for the whole population due to the absence of previous Uber or ridesourcing user data. The survey data was analysed to understand why travellers in London with diverse socio-demographic characteristics and travel preferences decide to use Uberpool services instead of UberX or traditional Taxi (i.e., Black cabs and minicabs). Uberpool users were asked to report the top three reasons why they chose Uberpool instead of UberX or traditional taxi services. The results show that 34.4% of Uberpool users stated they chose Uberpool because "It is cheaper", while 21.9% stated because it is "more environmentally friendly" and 14.8% because "they want to help reduce traffic congestion", as detailed in Table 23. The results indicate that Uberpool users are trip cost-sensitive and are concerned about the environmental and congestion consequences of their transport choice compared to UberX users. These findings might be attributed to the age groups of Uberpool users, who were mainly in the 31 or older age categories and therefore might be more aware and concerned about the effects of their mode choice. Furthermore, 13.5% of Uberpool users stated they use the service because they "want to meet people during the trip". This finding was another observation that Uber drivers explained during the focus group sessions as a regular and sometimes daily occurrence. Some of the findings regarding the 'reasons for using the service' are comparable to previous research such as (Chen, 2015; Zhao & Dawes, 2016; Young & Farber, 2019). Thus, the findings are considered valid for the population with the same socio-demographic characteristics.

Table 23. Reasons for Using Uberpool Instead of UberX or Taxi

	Results *(n=1232 out of possible 1350 responses)*	
Response categories	**Frequency**	**Percentage**
It is cheaper	424	34.4%
More environmentally friendly	270	21.9%
I want to help reduce traffic congestion	182	14.8%
Want to meet people during trip	166	13.5%
It is safer	118	9.6%
It is quicker	67	5.4%
Other	5	0.4%

The Uber app provides an estimated trip fare comparison for all the available Uber services before the user selects a particular service. Accordingly, to further understand the effect of trip fare saving (i.e., the trip fare saving compared to UberX) on service choice, Uberpool users were also asked (on average) how much fare saving they made by choosing Uberpool instead of UberX for that trip. The results showed that 57.1% of Uberpool users indicated they chose the service because they made a trip fare saving of 11% to 30% by opting for Uberpool instead of UberX, while 24% said they made a saving of over 35%.

UberX users were asked the top three reasons for choosing UberX instead of Uberpool to compare why users choose one type of Uber service over another. The results show that 29.4% of UberX users stated they used the UberX service because it is "quicker". However, 20.0% said it was because "They do not want to share with strangers", and 18.2% indicating they used it because "They do not want any delays during the trip". These findings indicate that a significant number of customers are deciding not to use shared services (i.e., Uberpool) because of concerns about sharing a trip with strangers and possibly longer journey times. Operators and policymakers will need to address this if shared ridesourcing is to become mainstream. It is not clear if these concerns are generally held views because of the media or if the travellers had tried the shared services and had a negative experience related to delays or other sharers.

Additionally, UberX users were asked to report the top three reasons they chose to use UberX instead of traditional taxi services (i.e., Black cabs or minicabs). The results show 30.4% of UberX users stated because it was "cheaper" and 23.6% said it was "easier to request and pay using the mobile app", whereas 16.3% indicated because "it is quicker" and overall, 9.5% said because they felt it was "safer". These results demonstrate that 54% of users prefer UberX over traditional taxi services due to lower trip cost or the ease of requesting and paying for the service. These findings correlate with feedback received during the pilot survey, where several customers explained they would not have used Uber at all if it were not for the mobile app and the cheaper trip cost. The Black cab and minicab services have developed app-based services but are still unable to compete with Uber on the trip cost and volume of available vehicles.

Why people use Uberpool, instead of PT and Active modes?

The users of both Uberpool were asked to indicate why they have used the service instead of PT options to assess the effect of Uber on traditional PT modes. Responses ranged from 1 = Strongly Disagree to 5 = Strongly Agree. The results show that Uberpool users either "agreed" or "strongly agreed" that they chose Uberpool instead of PT services because it is "quicker", "safer", "more comfortable to travel by car", and "easier to request and pay". At the same time, they also "strongly disagreed" that a reason they would use Uber is that there were no PT stops/stations near the origin or destination of their trip, as detailed in Table 24.

A Chi-square test was performed to compare UberX and Uberpool users' responses for each response category of "reasons for using Uberpool and UberX instead of PT" for both services, and the results indicated significant differences between users on all responses except for "door-to-door service" ($\chi 2$ (df) = 6.84; P-Value = 0.146). Notable differences included that Uberpool users were more likely to "disagree" or "strongly disagree" that Uber services were "cheaper than PT" (65.9% Vs 46.1%). Additionally, Uberpool users were more likely than UberX users to "disagree" or "strongly disagree" that there were "no PT stations/stops near their trip origin/destination" (53.0% vs 38.0%). In the survey, there was no specific option for "cleanliness" as a possible reason for using Uberpool/UberX instead of PT or Uberpool instead of UberX/Taxi. Also, previous literature did not indicate cleanliness as a key factor when deciding ridesourcing options instead of PT modes or a traditional taxi. Moreover, Uber provides a premium option (i.e., Uber Lux), which is more expensive and uses luxury vehicles aimed at a small segment of Uber users looking for higher levels of luxury (i.e., comfort, cleanliness, and service) compared to the standard UberX or Uberpool.

Table 24. Reasons for Using Uberpool and UberX Instead of PT options (Descriptive Analysis Results)

Response Options	UberX		Uberpool		UberX Vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
It is cheaper	***n* = 417**		***n* = 437**		
Strongly Disagree	42	10.1%	106	24.3%	
Disagree	150	36.0%	182	41.6%	
Undecided/Neutral	34	8.2%	35	8.0%	
Agree	71	17.0%	30	6.9%	
Strongly Agree	120	28.8%	84	19.2%	
					0.000
It is quicker	***n* = 434**		***n* = 447**		
Strongly Disagree	5	1.2%	4	0.9%	
Disagree	13	3.0%	8	1.8%	
Undecided/Neutral	22	5.1%	17	3.8%	
Agree	148	34.1%	103	23.0%	
Strongly Agree	246	56.7%	315	70.5%	
					0.000
It is safer	***n* = 413**		***n* = 450**		
Strongly Disagree	10	2.4%	2	0.4%	
Disagree	20	4.8%	7	1.6%	
Undecided/Neutral	91	22.0%	60	13.3%	
Agree	110	26.6%	166	36.9%	
Strongly Agree	182	44.1%	215	47.8%	
					0.000
More comfortable to travel by car	***n* = 429**		***n* = 450**		
Strongly Disagree	2	0.5%	2	0.4%	
Disagree	14	3.3%	9	2.0%	
Undecided/Neutral	43	10.0%	37	8.2%	
Agree	133	31.0%	125	27.8%	
Strongly Agree	237	55.2%	277	61.6%	
					0.047
Door to Door Service	***n* = 429**		***n* = 450**		
Strongly Disagree	6	1.4%	4	0.9%	
Disagree	10	2.3%	18	4.0%	
Undecided/Neutral	42	9.7%	45	10.0%	
Agree	131	30.3%	157	35.0%	
Strongly Agree	244	56.4%	225	50.1%	
					0.146
Ease of requesting service and payment	***n* = 427**		***n* = 447**		
Strongly Disagree	5	1.2%	2	0.4%	
Disagree	19	4.4%	14	3.1%	
Undecided/Neutral	40	9.4%	41	9.2%	
Agree	145	34.0%	122	27.3%	
Strongly Agree	218	51.1%	268	60.0%	
					0.017
No public transport near Origin/Dest.	***n* = 422**		***n* = 432**		
Strongly Disagree	52	12.7%	92	21.3%	
Disagree	104	25.3%	137	31.7%	
Undecided/Neutral	106	25.8%	57	13.2%	
Agree	71	17.3%	56	13.0%	
Strongly Agree	78	19.0%	90	20.8%	
					0.011

These findings illustrate that the travellers opt to use Uber services because PT options are considered inadequate in terms of comfort, safety, and travel time. This is an image and a service issue that public transport operators and transport authorities need to deal with if they are to avoid more people opting for ridesourcing services.

When the respondents were asked if they "would you still use Uber, if they had better access to PT options", the results showed, the majority of both UberX and Uberpool users would still use Uber (64.6%, 56.1%; respectively), so this indicates that it is not just about better access alone but addressing the travellers' concerns regarding the levels of comfort, safety, and travel time of PT modes. The results from a Chi-Square difference test indicate that there were statistically significant ($\chi 2$ (df) = 10.32; P-Value = 0.016) differences between UberX and Uberpool users' responses. Notably, Uberpool users were more likely to report that they would only use Uber for specific journeys if they had better access to public transport options (30.5% Vs 21.5%).

Furthermore, to assess the effect of Uber on active modes (i.e., Walking & Cycling), the users of both Uberpool and UberX services were asked why they have chosen to use Uber services instead of active modes. The majority of both UberX and Uberpool users "agreed" or "strongly agreed" that they chose Uber over walking/cycling because "it is Quicker (96.5%, 95.6; respectively), "Safer" (83.7%, 93.1%; respectively), "more Comfortable to travel by car" (85.5%, 90.0%; respectively), "Too far to walk or cycle" (81.7%, 84.8%; respectively), "Ease of requesting and paying for Uber" (78.6%, 87.4%, respectively) and "They do not have access to a bike" (68.4%, 79.3%, respectively). Furthermore, the results from a Chi-Square difference test shows a statistically significant difference on all responses, except for "it is too far to walk or cycle." A notable difference is that Uberpool users were more likely to report that they "strongly agreed" instead of "agreed" with the above response options. The detailed results tables are found in Appendix C.

7.3 Categorical Regression (CATREG) Modelling Results

Introduction

As part of quantitative data analysis for this study, a number of CATREG models were developed to find a deeper understanding of the key factors that affect the use of Uberpool services and the reasons for using the services. The methodology used for the quantitative data collection and analysis is presented in chapter Four of this thesis.

CATREG generates the relative importance of the predictor variables using Pratt's measure of importance, which clarifies predictor variables' contribution. The predictor variables with a large relative importance to the other variables indicate its level of significance, therefore, helping to explain the degree of influence by the predictor variables. The CATREG models also generate the transformation plots that indicate each variable's quantifications, as presented in Appendix D.

For this study, four main CATREG models were developed, and this sub-section presents a summary of each model's results. For each model, the dependent and independent (i.e., factors) variables were identified as described in Chapter Three of this thesis.

For each CATREG model, all the independent variables were included in the initial model one by one and tested to see if they have an influence on the model in terms of significance, importance and effect on the beta and goodness of fit test of the model. Subsequently, any insignificant independent variable was removed from the model. An iterative process was followed to conduct numerous models runs for checking the variations in significances until the p-value remains within a 95% confidence interval for multiple runs, then the ultimate model was achieved.

For each model, the R-square results are presented, which is the goodness-of-fit measure that gives the percentage of variance in the dependent variable, explained by the independent variable(s). In contrast, the adjusted R-squared compares the goodness-of-fit for the models that have many different independent variables. It helps explain how much of the correlation is attributed to the added independent variable and if that variable increases the model fit. The adjusted R-squared value usually increases only when the added new independent variable improves the model fit better than expected by chance alone and decreases when that variable does not improve the model fit that much.

All the CATREG model results presented in this section should be read in conjunction with the corresponding quantification plots that are provided in Appendix D, which were obtained at the same time when the CATREG models were undertaken. The quantification plots are helpful for checking the changes in quantifications for different categories of the factors while considering the beta value. The importance of data changes proportionally to the quantifications when the beta value is found to be positive. However, if the beta value is found to be negative, that indicates the change is related to the quantifications but in an inverted way.

CATREG Model 1: The factors that affect the frequency of using Uberpool services

This CATREG model was developed to understand the primary factors that affect the frequency of using Uberpool services. A total of 18 different factors were tested in an iterative process to reach the final model. The results for all the "factors that affect the frequency of using Uberpool services", including the importance levels, beta values and the R-squared results, are presented in Table 25. These results should be read in parallel with the corresponding quantification plots in Figure 9 in Appendix D. The quantification plots help understand the changes in quantifications for different categories of the factors while considering the beta value.

Table 25: The factors that affect the frequency of using Uberpool services

Dependent Variable: The frequency of using Uberpool services						
Categories	**Factors** *(Independent variables)*	**Beta**	**Pratt's Importance**	**Sig.** (P-Value)	*R Square*	*Adjusted R Square*
					0.392	0.347
Socio-demographics	Age group	0.231	0.159	0.000		
Trip characteristics	Trip Purpose	0.129	0.089	0.000		
	Trip Origin/Start	0.161	0.098	0.000		
	Average fare Saving Compared to UberX Service	0.229	0.160	0.000		
	Time of the trip _ Night	0.179	0.170	0.001		
	Time of the trip _ Weekdays	0.158	0.117	0.002		
User perception about the service	Perceived quickness of services compared to PT modes	0.143	0.082	0.005		
	Perceived safety compared to PT modes	0.167	0.126	0.003		

High: Pratt's importance [> 0.15]

Medium: Pratt's importance [0.10 – 0.15]

Low: Pratt's importance [0 - 0.09]

Pratt's importance measure helps to understand the contributions of the predictor variables to the regression. The predictors with large individual relative importance to other variables indicate its significance to the regression. Moreover, pratt's importance measure indicates the suppressor variables (i.e., a predictor variable that considerably improves the prediction of a criterion), showing lower relative importance compared to a variable that has a coefficient of similar size. Therefore, for CATREG model 1, the level of impact of the significant factors (i.e., the independent variables in the model with the highest importance) as indicated by pratt's importance results was categorised as high, medium, or low and are presented in Table 25 along with the standardised regression coefficients. This should be read in conjunction with Appendix D, which shows the response options for each independent variable and the related quantification plots.

The results for CATREG model 1 indicate that the frequency of travellers using Uberpool services is influenced by several factors of the traveller's socio-demographics, trip characteristics and perception about the Uberpool service, similar to previous research by Hou et al. (2020). The three factors that were most important in the model with high significance were "age group", "fare saving compared to UberX", and "time of the trip (night)". These findings correlate with the initial findings from the descriptive analysis of the Uberpool survey data, which showed that the age of Uberpool users varied across most age groups, and the service is used significantly at night, especially during high demand times when Uber surge pricing is activated. Moreover, one of the main draws to people using Uberpool appears to be the lower trip fare compared to the other available for-hire services. The other important factors that influence how frequently the services are used include the traveller's perception about how "quick" and "safe" the service is, compared to PT modes and where the trips start and end. These findings were aligned with previous research by Alemi et al. (2019) and Lavieri & Bhat (2019). This is an important finding for PT operators and policymakers to explore opportunities for integrating shared ridesourcing with PT services or using it to fill gaps in the PT network, based on location, time of travel and trip purpose.

CATREG Model 2: The factors that affect passengers' decision to use Uberpool instead of PT modes

This CATREG model was developed to understand the key *"factors that affect passengers' decision to use Uberpool instead of PT modes*". For this CATREG model, there were three sub-models developed, one for each response option of the primary dependent variable:

1. CATREG model 2A: "The factors that affect passengers' decision to use Uberpool instead of PT modes, because it is cheaper".
2. CATREG model 2B: "The factors that affect the passengers' decision to use Uberpool instead of PT modes, because it is a door-to-door Service'".
3. CATREG model 2C: "The factors that affect passengers' decision to use Uberpool instead of PT modes, because there is no PT stop/station near my origin/destination".

The results are presented for all three models that examined "the factors that affect passengers' decision to use Uberpool instead of public transport modes", including details of the beta values, importance levels, and the R-squared results.

For CATREG models 2A, 2B and 2C, the final models were reached after iteratively testing 17 different factors to check how each (and or a group of the factors) affected the model overall and the model's goodness-of-fit test. For model 2A, nine key factors had a significant effect on the model. In contrast, for model 2B and 2C, six key factors affected "*the passengers' decision to use Uberpool instead of public transport modes, because it was a door-to-door service"* and *"because there was no PT stop/station near origin/destination"* as detailed in Table 26.

Table 26. Results: Models 2A, 2B & 2C:The factors that affect passengers' decision to use Uberpool instead of public transport modes.

		Model 2A Results: The factors that affect passengers' decision to use Uberpool instead of public transport modes, 'because it is Cheaper'.					Model 2B Results: The factors that affect passengers' decision to use Uberpool instead of public transport modes, 'because it is a door-to-door service'.					Model 2C Results:The factors that affect passengers' decision to use Uberpool instead of public transport modes, 'because there is no PT stop/station near origin/destination.				
Categories	**Factors** *(independent variables)*	**Beta**	**Pratt's Importance**	**Sig. (P Value)**	R Square	Adjusted R Square	**Beta**	**Pratt's Importance**	**Sig. (P Value)**	R Square	Adjusted R Square	**Beta**	**Pratt's Importance**	**Sig. (P Value)**	R Square	Adjusted R Square
					0.525	**0.477**				**0.433**	**0.394**				**0.208**	**0.153**
Socio-demographics	Age group	0.172	0.057	0.000			0.151	0.045	0.000			0.138	0.090	0.000		
	Employment status	0.174	0.055	0.000			0.095	0.021	0.000							
	Highest Education Level completed						0.120	0.055	0.001			0.124	0.081	0.000		
Trip characteristics	Trip Purpose	0.107	0.041	0.001			0.159	0.082	0.000			0.204	0.170	0.000		
	Trip Origin/Start	0.155	0.057	0.000			0.140	0.069	0.000			0.114	0.042	0.000		
User perception about the service	Perceived quickness of services compared to PT modes	0.154	0.093	0.005								0.219	0.274	0.001		
	Perceived safety compared to PT modes	0.191	0.185	0.001			0.540	0.729	0.000			0.256	0.342	0.000		
	Any objection to divert during trip to pickup/drop-off others	0.126	0.039	0.000												
	Uberpool Service Rating	0.182	0.155	0.000												
Access to alternative modes.	Car ownership at present	0.321	0.318	0.000												

High: Pratt's importance [> 0.12]

Medium: Pratt's importance [0.05 – 0.12]

Low: Pratt's importance [0.00 – 0.04]

The pratt's importance results were categorised as high, medium, or low for this model, as shown above, and in Table 26 alongside the standardised regression coefficients (beta) and p-values for each independent variable.

Understanding why travellers opt for Uberpool instead of PT modes was crucial for this research. Therefore, to uncover all possible factors influencing the traveller's choices, three separate models were run, one for each dependent variable option. The results show that different aspects of the traveller's socio-demographics, trip characteristics, perception about Uberpool service, and access to alternative modes such as a personal car all play a role in why travellers use Uberpool instead of the many PT options that are available in London. The findings show that the "perception on safety, compared to PT modes", "how they rated Uberpool service", and "car ownership at present" were the most significant factors that affect why travellers use Uberpool instead of PT. So, travellers without a car at present are more likely to use Uberpool instead of PT. Moreover, other factors such as employment status (e.g., employed travellers are more likely to use Uberpool over PT), trip purpose and trip origin were also significant.

Additionally, similar results were observed for the factors that affect travellers' decision to use Uberpool instead of PT modes, "because there was no PT stop/station nearby" or because Uberpool was considered a "door-to-door service". Also, the age group, trip purpose, and perception about safety or quickness of the service were highly significant as indicated in the related quantification plots shown in figure 10 in Appendix D. The findings reveal that perception about PT modes safety is vital when travellers are deciding between Uberpool and PT. This could be more so during night-time, where Uberpool usage increases. The issue relating to the efficiency of the PT modes requires further study since it was not clear from the data if this was explicitly referring to PT buses or all PT modes.

CATREG Model 3: The factors that affect a passengers' decision to use Uberpool instead of UberX or Traditional Taxi

This CATREG model was developed to understand *the "factors that affect a passengers' decision to use Uberpool instead of UberX or Traditional Taxi"*. Traditional taxi here refers to both Black cabs and minicabs. There were five sub-models because the dependent variable has six different response options; however, the first response option (i.e., because it was "cheaper") was excluded from the model since there was not sufficient variation in the data. The five models were as follows:

1. CATREG model 3A: "The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi, because it is quicker".
2. CATREG model 3B: "The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, because they want to meet people during the trip".
3. CATREG model 3C: "The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, because it is safer".
4. CATREG model 3D: "The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi, because it is more environmentally friendly".
5. CATREG model 3E: "The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi, because they want to help reduce traffic congestion".

The final CATREG models were achieved after iteratively testing 17 different factors to check how each (and or a group of the factors) affected the model and the model's goodness-of-fit test. There are eight key factors that affect the passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is quicker' (i.e., model 3A). In addition, there were six factors that significantly affect the passengers' decision to use Uberpool instead of UberX or Traditional Taxi, "because the passenger wants to meet people during the trip"; it is "safer", or the "passenger wants to help reduce traffic" (i.e., models 3B, 3C, & 3E). Moreover, there were seven key factors that affect the passengers' decision to use Uberpool instead of UberX or Traditional Taxi "because it was more environmentally friendly" (i.e., model 3D), as detailed in Table 27.

Table 27. Model 3 Results: The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi

		Model 3A Result:. The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is quicker'.					Model 3B Results: The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because they want to meet people during trip'.					Model 3C Results: The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is safer'.					Model 3D Results: The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is more environmentally friendly.					Model 3E Results: The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because the user wants to help reduce traffic'.				
Categories	**Factors** *(independent variables)*	**Beta**	**Pratt's Importance**	Sig. (P Value)	*R Square*	*Adjusted R Square*	**Beta**	**Pratt's Importance**	Sig. (P Value)	*R Square*	*Adjusted R Square*	**Beta**	**Pratt's Importance**	**Sig.** (P Value)	*R Square*	*Adjusted R Square*	**Beta**	**Pratt's Importance**	**Sig.** (P Value)	*R Square*	*Adjusted R Square*	**Beta**	**Pratt's Importance**	**Sig.** (P Value)	*R Square*	*Adjusted R Square*
					0.301	0.226				0.211	0.138				0.179	0.106				0.177	0.074				0.186	0.111
Socio-demographics	Age group	0.096	0.014	0.000			0.220	0.212	0.000			0.166	0.135	0.000			0.111	0.061	0.005			0.271	0.357	0.000		
	Employment status	0.145	0.018	0.003			0.125	0.031	0.006								0.163	0.107	0.005			0.146	0.019	0.001		
	Highest Education Level completed	0.157	0.051	0.000			0.132	0.098	0.000			0.182	0.182	0.000			0.183	0.145	0.000			0.133	0.093	0.000		
Trip characteristics	Trip Purpose	0.163	0.060	0.000			0.330	0.523	0.000			0.190	0.170	0.000			0.278	0.233	0.000			0.215	0.284	0.000		
	Trip Origin/Start	0.237	0.129	0.000			0.140	0.090	0.000			0.164	0.086	0.000			0.194	0.034	0.000			0.129	0.095	0.000		
	Average fare Saving Compared to UberX	0.397	0.582	0.000			0.110	0.045	0.000			0.212	0.306	0.000			0.159	0.187	0.000			0.156	0.151	0.000		
User perception about the service	Any objection to divert during trip to pickup/drop-off others	0.131	0.065	0.001																						
	Uberpool Service Rating	0.119	0.081	0.008								0.113	0.122	0.009												
Access to alternative modes.	Car ownership at present																0.198	0.233	0.016							

High: Pratt’s importance [> 0.12]

Medium: Pratt’s importance [0.05 – 0.12]

Low: Pratt’s importance [0.00 – 0.04]

Similar to previous CATREG models, the pratt's importance results for model 3 were categorised as high, medium, or low, as shown above, and in Table 27 along with the standardised regression coefficients (beta) and p-values for each independent variable.

In CATREG model 3, the dependent variable had five variations (response options); accordingly, five models were run to understand more about the most important "factors that affect a passengers' decision to use Uberpool instead of UberX or Traditional Taxi", that were applicable to each dependent variable option. The results indicate that important socio-demographics, trip characteristics, perception about the service, and access to a personal car are all factors that significantly influence why travellers in London choose to use Uberpool instead of UberX or a traditional taxi. Furthermore, the most important factors across all five models were 'fare saving, trip purpose and origin, age group and education level. Also, car ownership at present was found to be highly important when users stated they chose Uberpool 'because they thought it was more environmentally friendly. Nevertheless, the "rating of the service" was important when users indicated they chose Uberpool "because they considered it safer or quicker", demonstrating the link between what users think about Uberpool service and reasons for usage in relation to safety and efficiency. The most important factors that influenced travellers' choice when they wanted to "meet other people during the trip" were found to be "age group" and "trip purpose". These findings correspond with findings from the focus group sessions that indicated mainly younger age groups were indicating to the Uber drivers that they wanted to meet other people during the trip.

CATREG Model 4: The Transport modes that Uberpool services are replacing

This CATREG model was developed to understand the factors that affect the "transport modes that Uberpool services are replacing". For this model, a total of 22 different factors were tested in an iterative process to assess how each (and or a group of the factors) affected the model and the goodness-of-fit test until the final model was achieved. The findings show, there were six key factors that affect the transport modes that Uberpool services are replacing, as presented in Table 28. The results should be read analogous with the corresponding quantification plots in Figure 18 in Appendix D that help understand the changes in quantifications for different categories of the factors taking into account the beta value.

Table 28: Results: 'The factors that affect the transport modes which Uberpool services are replacing.

Dependent Variable: The factors that affect the transport modes which Uberpool services are replacing.							
Categories	**Factors** *(Independent variables)*.	**Beta**	**Pratt's Importance**	**Sig.** (p-value).	R Square	Adjusted R Square
					0.306	0.258
Socio-demographics	Age group	0.124	0.025	0.000		
	Employment status	0.183	0.163	0.004		
	Highest Education Level completed	0.069	0.010	0.002		
Trip characteristics	Trip Purpose	0.407	0.607	0.000		
	Trip Origin/Start	0.142	0.087	0.000		
Access to alternative modes.	Owner of Oyster/Travel Card	0.196	0.108	0.004		

High: Pratt's importance [> 0.11]

Medium: Pratt's importance [0.04 – 0.11]

Low: Pratt's importance [0 – 0.03]

For the final CATREG model, the pratt's importance results for model 4 were also grouped into high, medium, or low as detailed above and in Table 28. In addition, the standardised regression coefficients (beta) and p-values for each independent variable are also provided for the final model in the same table.

The CATREG modelling results reveal that the other transport modes that Uberpool services are replacing are influenced by numerous factors that include different aspects of the traveller's socio-demographics, trip characteristics and access to alternative modes. The three most important factors that significantly affect how Uberpool is replacing other traditional PT modes were found to be "trip purpose", "employment status", and the ownership of "Oyster/Travelcard". In addition, the trip purpose and origin were shown as important factors which affect the PT modes that are being replaced by Uberpool services are replacing. This might be explained by when trips are made by Uberpool, such as social trips at night where travellers might prefer Uber instead of night bus or trains to reach home.

The primary Uberpool user survey data indicated that a significant number of Uberpool users are shifting from PT modes such as PT buses, Tube, and trains. Therefore, the significance of owning a travel/oyster card indicates that PT users are more likely to use Uberpool either as a complementary mode or to replace some of their PT mode trips. As such, the results highlighted the most important factors to consider when developing shared ridesourcing policies in relation to PT modes. These findings are important for understanding the effect on primary PT modes and providing the empirical data needed for policymakers to address any negative impacts from shared ridesourcing.

7.4 Chapter Summary

This chapter presented the results from the quantitative data analysis, including the results from the initial descriptive statistical analysis, which included cross-tabulation analysis and Chi-square tests. The findings relating to essential aspects of Uberpool that were important to the research are presented, such as who used Uberpool and UberX, when and how frequent the two services were used, the main trip purposes and key factors that influenced the use of Uberpool instead of other modes.

The findings revealed that most Uberpool and UberX users who responded to the survey were employed/self-employed, with most users having completed at least an undergraduate/college education (UberX; 92.6% and Uberpool; 89.5%) with around 15% of users being students. More than half of Uberpool users used the service weekly, including 31% who used it "2-4 times a week" and 27% who used it "once or twice a week" and the majority (56.4%) always used the service at night, or used it during the weekend (48.4%). Moreover, the main trip purposes for Uberpool trips included going to/from "school, college or work", "PT station/stop", or "home", while 13.5% indicated they used the service because they wanted to "meet people during the trip".

The results also showed that 60% of Uberpool and 54.4% of UberX users used PT modes (i.e., Tube/Train/Tram or Bus) for the same or similar trips before using Uber. There was a 6.5% decrease in car ownership for UberX users and a 9.4% for Uberpool users after they started using the service. The results also indicated users chose

Uberpool instead of PT mainly because they considered it to be "quicker", "safer", "more comfortable to travel by car", or "easier to request and pay".

Several CATREG models were developed to understand better the key factors that influenced the use of Uberpool services and the reasons for usage. The modelling results showed that the frequency of travellers' use of Uberpool was influenced by several factors of the traveller's socio-demographics (i.e., age group), trip characteristics (i.e., trip purpose and time of the trip) and perception about the Uberpool service (i.e., safety, quickness compared to PT modes). Moreover, the primary factors that influenced why travellers used Uberpool instead of PT included the "perception on safety, compared to PT modes", how respondents "rated Uberpool service", and whether respondents "owned a car at present". At the same time, "employment status", "trip purpose", and "trip origin" were also important factors.

There are important and new findings offered in this chapter that give essential empirical data for PT operators and policymakers, and other important stakeholders to help understand the effects of Uberpool services, how it is being used and why and its relationship with traditional PT modes in an urban context. The findings may be used by PT operators and policymakers to explore opportunities for integrating shared ridesourcing with other mainstream PT services or promoting a context-based use of the service (i.e., location, time, or trip purpose) that helps to fill gaps in the PT network, rather than taking trips away from PT modes such as buses and the Tube.

The next and final chapter of the thesis provides a summary of the research findings, main discussion points and conclusions for this research.

Chapter 8: Conclusion

8.1 Introduction

This research aimed to understand ridesourcing usage characteristics and explore the implications of Uberpool on public transport in terms of policy and operation. In addition to how these services work with traditional PT modes. The study was conducted using Uberpool and UberX services in London as a case study.

This concluding chapter of the thesis summarises key findings while outlining how the research questions were answered using discussions from the interviews, focus groups and Uber user survey data. The findings provide the first empirical data on shared and non-shared ridesourcing services in the UK, thus offering essential insights about ridesourcing usage characteristics and the possible consequences from these services on traditional PT modes.

The main discussion points and details of contribution to knowledge and key recommendations for transport authorities, policymakers and PT operators are offered. The research limitations and suggestions for future studies are also presented.

8.2 Summary of The Findings

This research explored the use of shared ridesourcing services (i.e., Uberpool) and its relationship with traditional PT modes. Using empirical data, the research intended to understand ridesourcing usage characteristics and the primary relationships between service utilisation and reasons travellers choose ridesourcing to inform transport policymaking in London. In addition, to investigating the implications of Uberpool on traditional PT modes in terms of policy and operation.

A review of relevant theories indicated that there were several pertinent theories that are used to explain why travellers use certain modes of transport over another, including rational choice theory, satisficing theory, and the theory of planned behaviour. Based on these theories, the determinants influencing travel behaviours include the availability of a car, the time and monetary costs involved; behaviours or decisions that are performed frequently; and variance in intentions and behaviour. Moreover, social psychological theories are sometimes used to explain travel behaviour, including sharing rides or vehicles. For example, social psychological theories such as the theory of planned behaviour and Hall's proxemics theory indicate that people's acceptance of sharing vehicles may be influenced by their attitude towards travel behaviour; subjective norms; perceived behavioural control and the level of discomfort resulting from the idea of sharing vehicles. Additionally, economic theories such as economic regulations are used to manage or limit market entry or control the price.

An extensive literature review was undertaken on ridesourcing services, and other on-demand shared mobility services and the following three main research gaps were identified.

1. It was discovered that most existing studies on ridesourcing were primarily undertaken in a North American context, mainly in the USA, and the findings do not adequately address the complex policy and operational issues, particularly in a European or the UK context. Moreover, there were no earlier studies (or ridesourcing data) focusing on London or the UK in general.
2. Shared ridesourcing is not sufficiently addressed in the current literature, including its effect and relationship with traditional PT modes. Moreover, with the absence of any empirical data, the consequences of shared ridesourcing services are not clearly understood, and there is no consensus on the best way to manage or regulate these services.
3. The previous studies mainly relied on one type of stakeholder's perspectives or data sources, such as the users or drivers. They, therefore, did not fully consider the perspectives from all necessary stakeholders such as the service providers (i.e., Uber), policymakers and transport authorities, the users, drivers, PT operators and industry experts.

To fill the research gaps identified from the literature review, contribute to the body of knowledge, and hence achieve the research aims, several research questions were developed. Table 29 summarises how the research questions have been answered, where full details of the results are found within this thesis, and a summary of key findings for each research question. The answers to the research questions provided a comprehensive UK context case study whilst offering insights on shared ridesourcing and its implications using primary empirical data and viewpoints from the main ridesourcing interested parties.

Uber in London was chosen as the case study because it offered an excellent opportunity for understanding the use of ridesourcing services due to the availability of shared and non-shared options, with Uber being the largest ridesourcing operator in London and the UK in general, and the extensive other transport options that are available within the city. In addition, London provides a specific transport policy and PT operations structure, including having a single transport authority, TfL, and having a well-integrated and expansive PT system.

A mixed-methods approach comprising quantitative and qualitative data was used. The quantitative data were collected using an intercept survey of UberX and Uberpool users in Greater London. However, the qualitative data were collected using a combination of interviews with 31 different participants representing transport policymakers, regulators, PT operators, industry experts/innovators and researchers and focus group sessions with 28 London Uber drivers. The interview and focus group data were analysed using a thematic approach to find meaningful themes in the data. However, the survey data was initially analysed using descriptive statistical analysis and cross-tabulation. Moreover, several categorical regression (CATREG) models were developed for the survey data to investigate and better understand the key factors that influenced how and why Uberpool services were used in London. The data collection and analysis methods are detailed in Chapter Three of this thesis.

A non-probability sampling method using a convenience sampling technique was used for this research. The surveys were administered via nine full-time Uber drivers from different parts of London. One thousand survey forms (500 UberX and 500 Uberpool) were issued to the Uber drivers to give the surveys to any willing passengers at the start of the trip. A total of 907 (450 UberX and 457 Uberpool) fully completed surveys forms were received.

The representativeness of the sample for the whole Uber user population was difficult to verify because there were no previous Uber or ridesourcing user data in London to check against, and TfL (at the time of the survey) did not collect any data about Uber (or other ridesourcing) usage. Moreover, the London Travel Demand Survey did not collect the socio-demographic characteristics of ridesourcing users, and typically, these were grouped with taxi and private hire mode data. However, the collected Uber user survey data is the first known independent data collected from Uber users in London, and therefore, the findings are considered valid for the user population with the same socio-demographic characteristics.

8.2.1 Answers to The Research Questions

All the research questions were answered during the various stages of the research. A high-level summary of the main findings for each research question and details of where to find full results within the thesis are presented below.

Table 29. Answering the research questions

Research Question	Method used	Location in the thesis	Summary of findings
(RQ1) How are UberX and Uberpool currently used in a city like London?			
(a) How frequently are these services used and by whom?	• Descriptive statistical analysis of Uber user survey data • Analysis of focus group data	Chapter 6 & 7	• The services are regularly used, including Uberpool services, which are used 2 to 3 times a week by over 31% of respondents. • The services are highly used by those aged between 18 to 35 years, people who are employed and well educated. • The frequency of using Uberpool was influenced by the users' socio-demographics (i.e., age group), trip characteristics (i.e., trip purpose and time of the trip) and perception about the Uberpool service (i.e., safety, quickness compared to PT modes).
b) When are UberX and Uberpool services used and for what trip purposes?	• Descriptive statistical analysis of Uber user survey data • Analysis of focus group data	Chapter 6 & 7	• The services are highly used during the night, evenings, and weekends. Although, it is sometimes used during weekday mornings. • The primary trip purposes included going to/from school, college, or work, PT station/stop, or home. Also, some used Uberpool to meet people during the trip.
c) What modes has Uber replaced?	• Descriptive statistical analysis of Uber user survey data	Chapter 7	• The results indicate that ridesourcing is mainly substituting PT trips, minicab and black cab trips and some active mode trips. • 60% of Uberpool users stated using PT modes for the same or similar trips before using Uber. These findings were similar to previous studies like Young, et al. (2020).
d) Are Uber services affecting car ownership?	• Descriptive statistical analysis of Uber user survey data	Chapter 7	• Some indication that Uber might be reducing car ownership, with over 9% of Uberpool users indicating they shed personal cars since they started using Uber. • Over 38% of Uberpool users indicated the availability of Uber had some/very high influence on their car ownership decision.

Table 29. Answering the research questions (continued)

(RQ2) What attracts people to Uberpool in a city like London?			
a) What is the socio-demographic profiles of Uberpool users compared to UberX?	• Descriptive statistical analysis of Uber user survey data • Analysis of focus group data	Chapter 6 & 7	• A higher percentage of Uberpool users were in older age groups (i.e., 36 to 56+) and owned an Oyster/travel card. • No significant differences were found in gender, education levels and employment status of UberX and Uberpool users. • Less Uberpool users owned personal car.
b) Why people use Uberpool, instead of UberX and traditional taxi?	• Descriptive statistical analysis of Uber user survey data • CATREG modelling of Uberpool user survey data • Analysis of focus group data	Chapter 6 & 7	• Users chose Uberpool generally because it was cheaper and considered more convenient. • Some users choose Uberpool to socialise during trips and find a date. • Other users chose Uberpool because it was considered more environmentally friendly, and it helps to reduce traffic congestion compared to single occupancy modes. • Key factors that influenced users' choice included fare savings, trip purpose & trip origin, age group and education level. Car ownership at present and environmentally friendly were also important.
c) Why people use Uberpool, instead of PT and Active modes?	• Descriptive statistical analysis of Uber user survey data • CATREG modelling of Uberpool user survey data	Chapter 7	• Most users chose Uberpool over PT and active modes mainly because Uberpool was considered a quicker and safer option, and it was more comfortable to travel by car and generally more convenient (i.e., ease of requesting & paying and door-to-door). • Some users chose Uberpool instead of active modes because it was too far to walk/cycle or they did not have access to a bicycle. • Key factors influencing users' mode choice included the perceptions of safety, compared to PT modes; how users rated Uberpool service and car ownership at present.

Table 29. Answering the research questions (continued)

(RQ3) How do transport authorities, and the conventional public transport industry deal with Uberpool in a city like London?			
a) Do transport authorities and policymakers understand the impact of Uber services in generally and specifically Uberpool?	• Analysis of Interview data	Chapter 5	• There is currently no existing data available on shared and non-shared ridesourcing in London, and therefore no understanding of its impact on other modes or congestion were limited. • Policymakers and transport authorities had limited understanding of Uberpool and its effects. • The policymakers and transport authorities have not caught up with the level of innovation caused by ridesourcing services.
b) How are the transport authorities and PT sector dealing with shared ridesourcing services?	• Analysis of Interview data	Chapter 5	• Transport authorities were unsure how best to deal with ridesourcing services, due to lack of data internal capacity challenges and there were no immediate plans for managing ridesourcing in London. • There is currently no specific regulation in place for shared and non-shared ridesourcing, and these services currently operate under the old private hire vehicles regulations. • The transport authorities were concerned about the safety of passengers using the shared service. • The PT bus operators were more proactive in exploring on-demand shared solutions that may complement some bus services or fill gaps in the PT bus network.
c) Do transport authorities in London have any existing mechanisms for monitoring impact of Uber services?	• Analysis of Interview data	Chapter 5	• There were no existing monitoring mechanisms in place for ridesourcing services, and the current London travel surveys do not include ridesourcing as a separate category. • Understanding the impacts of ridesourcing was important to policymakers and transport authorities, but there were no immediate plans to develop monitoring systems.

Synthesis of the findings

The literature review for this study revealed that previous research on ridesourcing generally relied upon a single data source or perspective. Therefore, to address the gap in the research and develop a comprehensive understanding of ridesourcing services, a multi-method approach was adopted using qualitative data collected using interviews with policymakers and key stakeholders and focus groups with Uber drivers, and quantitative data collected using intercept surveys of Uber users in London as detailed in Chapter 3 of this thesis. The three methods were applied to consider different perspectives, including those who operate the service, those that use the service, and other key stakeholders such as policymakers and regulators. In addition, obtaining the different data allowed triangulation techniques to be used to assess and validate the findings from the three data sources and thus enhance the reliability of the research findings. This technique is commonly used in empirical research to validate the results of different data collection methods to enhance validity, provide in-depth understanding, or interrogate different ways of understanding a research problem. In this study, triangulation techniques helped identify where some of the results from the different methods converged, complemented, or differed.

The interviews were used to investigate whether policymakers, transport authorities, and PT operators in London and the broader transport industry understood Uber services' operational and policy implications and offered new evidence on the effects, challenges, and opportunities arising from Uber operations in the UK and European city context. The focus groups were used to gather crucial information and perspectives from Uber drivers in London to help answer key research questions, particularly on how Uberpool and UberX services were used and why users adopted Uberpool instead of other modes. In addition to obtaining other insights, first-hand experiences, and general perspectives of the Uber drivers.

With the absence of existing ridesourcing trip-making and user characteristics data in London, it was important for this research to obtain empirical data on shared and non-shared ridesourcing user sociodemographic, trip characteristics, frequency of use and reasons for mode choice. Therefore, the Uber user survey was designed to obtain important quantitative data on vital aspects of Uberpool and UberX services in London. This included who used Uberpool and UberX, when and how frequently the two services were used, the primary trip purposes, user sociodemographic and key factors that influenced the use of Uberpool instead of other available modes.

The findings from the interviews showed that there was a general understanding among the interviewees about how the Uberpool service operated, and Uberpool was viewed positively as part of a future transport system, providing it is used to fill gaps in the PT network or at low ridership PT bus routes. However, policymakers were concerned about the safety of passengers using the service, which was contrary to the Uber user survey data that showed Uber users generally had no major safety concerns while using the service. The results from the focus groups were aligned with the user survey in that they indicated travellers considered Uber safe because users are able to share their travel route with relatives or friends, and they can report any concerns via the application because all information about each trip is saved in the users Uber App. The policymakers' concerns about safety may have been based on media reports and the high-profile court cases involving TfL and Uber since there was no empirical data on Uber passenger safety. Furthermore, there were indications that policymakers and the PT sector were generally slow in adapting to the disruptions caused by ridesourcing services such as Uber, which may be contributed by the pace of development and various organisational capacity challenges they are facing.

The viewpoints of the different interviewees were varied; however, most of them were unsure about how to deal with ridesourcing services, and there were no immediate plans in place by TfL for managing these services. There is currently no existing data available on ridesourcing in London, and no mechanisms exist to monitor or assess its effects. This has led to a genuine lack of knowledge among policymakers and transport authorities on how they approach these services in terms of regulations, operational guidelines and integration with other modes and future transport systems. The PT bus operators appeared to be more proactive in looking at on-demand shared solutions that may complement some bus services or fill gaps in the bus network, such as Tower Transit with the CM2 service. Moreover, most PT bus operators interviewed who operate in the Greater London area indicated the lack of innovation and integration with new mobility solutions was mainly due to how PT bus services are set up, which is a fixed-term and fixed-route contract system, regardless of the number of users for each route. So, operators are looking to TfL, who manage PT bus services contracts, to guide how services should be planned and provided in the era of new (shared and on-demand) mobility services. The interviewees commonly acknowledged that these disruptive and novel services were considered popular with users and were perceived as providing convenient and cost-effective mobility to users, which was in line with the findings from the focus group and survey data. The lack of data, pace of change, understanding of its specific effects and, to some extent political-will, have contributed to how policymakers have reacted so far in London.

The focus groups were designed to complement the interview data by providing additional data from the Uber drivers so that views from different stakeholders are considered in the research. The findings revealed that approximately 20%-30% of the daily Uber requests per driver were usually for the Uberpool service, and one of the main benefits highlighted was the number of jobs it has created in London and the flexibility it offers to the drivers. However, there was a need for all stakeholders to work together on driver welfare issues (i.e., working hours and employee benefits) and how the service should be managed (e.g., driver numbers) and addressing the concerns from the drivers about actions by TfL on ridesourcing services. The Uber drivers indicated that travellers were using Uberpool because it was perceived as cheaper and more convenient compared to alternative modes. The primary Uberpool users included students and those making social trips such as a night out in the city.

Additionally, Uber drivers reported that many travellers use Uberpool to socialise during trips and, in some instances, to find a date, which appears to be an additional reason for adopting shared ridesourcing. This discovery correlates with the Uber user survey data. The focus group data indicated that Uber served many first and last-mile trips and was replacing mainly PT or traditional trips while also catering for new trips that may not have been made before, although to what extent was unclear from the focus group discussions. Again, this was consistent with the findings from the Uber survey data and previous research such as Hall et al. (2018).

The Uber user survey was used to collect quantitative data on different aspects of Uberpool and UberX services in London. The findings showed that over 51% of Uberpool and 67% of UberX users indicated they were 18 to 35 years old. However, more Uberpool users were in the older age groups (e.g., 36 to 56 yrs.), which contradicted the general perception that Uberpool users were young. In addition, the majority of responders were employed (including self-employed) with at least an undergraduate education, and around 15% of responders were students. More than half of Uberpool users used the service weekly, including 31% who used it "2-4 times a week" and 27% who used it "once or twice a week" while over 56% always used the service at night and

48% used it during the weekend. This was supported by the feedback from the Uber drivers who indicated that services were used significantly during evenings, weekends and at nights, particularly for social trips. In addition, the primary trip purposes for Uberpool trips were going to/from "school, college or work", "PT station/stop", or "home", and nearly 14% indicated they used the service because they wanted to "meet people during the trip", again reiterating the comments from the Uber drivers during the focus group discussions. Also, some of the findings regarding the 'reasons for using the service' are comparable to previous research findings by Chen (2015), Zhao & Dawes, (2016) and Young & Farber (2019).

Furthermore, over half of UberX users and 60% of Uberpool users said they used PT (i.e., The tube, PT buses) for the same or similar trips before using Uber, suggesting that ridesourcing is affecting PT trips, which could have significant consequences if this trend continues. This finding aligns with the focus groups results and previous studies such as Clewlow & Mishra (2017), Martin & Shaheen (2011), and Young et al. (2020). The users revealed they chose Uberpool instead of PT mainly because they considered it to be "quicker", "safer", "more comfortable to travel by car", or "easier to request and pay", which supports earlier findings from the focus groups and previous research by Rayle et al. (2014) & Chen (2015). Also, ridesourcing seems to be helping to reduce car ownership since travellers are now able to get access to car travel easily and quickly without the need to own a car with all the associated costs.

The statistical modelling of the Uberpool user survey data showed that the frequency of using Uberpool was influenced by the users' socio-demographics such as their age group – similar to findings by Alemi et al. (2019), trip characteristics (i.e., trip purpose and time of the trip) and perception about the Uberpool service (i.e., safety, quickness compared to PT modes). The primary factors that influenced reasons for using Uberpool instead of PT included the "perception on safety, compared to PT modes", how respondents "rated Uberpool service", and whether respondents "owned a car at present". At the same time, "employment status", "trip purpose", and "trip origin" were also important influencing factors.

The Uber user survey results offered new and essential empirical data that provides support to policymakers, transport authorities, PT operators and other important stakeholders. The findings provide more understanding of shared and non-shared ridesourcing services in London, how, when, and why they are used, who uses these services, and its potential effects on traditional PT modes in an urban context. Also, it supports when considering opportunities for integrating shared ridesourcing with other PT services or developing new context-based services that might be location, time, or trip purpose specific to fill gaps in the PT network.

The findings presented in this thesis provide important insights, data, and understandings about ridesourcing services in London. This was the first research on ridesourcing that combined the use of user surveys, driver focus groups and interviews with policymakers and key stakeholders. This approach allowed different perspectives and responses to be considered using qualitative and quantitative data collection methods. The findings help answer the research questions, contribute to the body of knowledge on the topic, and fill the research gaps identified in Chapter two of this thesis.

8.3 Discussion and Recommendations

8.3.1 Discussion

The availability and use of Uber services in London has grown rapidly since it was launched in London, with over 3.5 million registered users and 40,000 drivers being quoted by Uber during the time of data collection for the study. The findings indicate that travellers were opting to use Uber services because they considered PT alternatives inadequate in terms of comfort, safety, and travel time. In addition, the results highlight the need for PT operators and transport authorities such as TfL to deal with the undesirable image and other service-related concerns of traditional PT modes (i.e., make PT more attractive) to inhibit more people from shifting from PT to ridesourcing services. Furthermore, TfL needs to cooperate with ridesourcing providers to help fill gaps in the network or replace low ridership PT bus routes that are already heavily subsidised with shared ridesourcing options contracted through a new type of PT bus and on-demand service contracts while also minimising direct competition in areas with adequate PT coverage. This may also encourage PT bus operators to innovate and explore ways of collaborating with ridesourcing service providers or offer their on-demand services similar to what Arriva is already piloting outside London.

The findings showed Uberpool safety-related concerns; therefore, the ridesourcing operators (such as Uber) and transport authorities will need to address any safety apprehensions in order to make shared mobility more mainstream compared with non-shared options. The ridesourcing operators should also implement public awareness initiatives in collaboration with TfL to counteract any misconceptions and negative views about shared ridesourcing and have clear messaging on how and where these services should be utilised.

The findings in this study provide useful understandings for policymakers, transport authorities, and PT operators. In addition, several key elements are discussed.

Uber Vs TfL in London

- In 2017 (shortly after the interview and focus group data were collected for this study), there was a high-profile legal case involving TfL and Uber, when TfL decided not to renew Uber's London operating licence (TfL, 2017). TfL cited various safety and compliance concerns, and the case was highly politicised and received global media coverage. Shortly afterwards, TfL issued a draft policy paper on ridesourcing, which indicated that policymakers and regulators would take steps to address some of the policy and regulatory gaps that exist; however, nothing tangible has been done since. Although Uber was eventually granted the London operating licence, several other court cases between Uber and TfL followed, including concerning compulsory English tests for drivers, the introduction of congestion charges on Uber services entering central London and most recently, the 2019 case regarding the non-renewal of Uber's London operating licence for the second time. These cases and the findings from the interviews and focus groups highlight the need for policymakers and transport authorities such as TfL to develop clear guidelines, policies and specific regulation that considers the city's priorities and helps to deal with all types of ridesourcing services, using the findings and recommendations from this study.
- There has also been a supreme court case brought against Uber in London by former Uber drivers that resulted in a 2021 supreme court ruling stating that all Uber drivers shall be classified as employees of Uber and not independent contractors as per the previous arrangements (see BBC, 2021). This ruling means that drivers should be classified as Uber employees and therefore entitled to employee benefits, including

holiday pay, minimum wage, and enrolment in a workplace pension scheme. This ruling helps to deal with one of the issues raised by the Uber drivers during the focus group discussions concerning driver welfare and the relationship between the drivers and Uber.

Ridesourcing Drivers' Union

- An issue faced by Uber drivers in London was the absence of any organisation that represented their profession and interests, unlike the London black cabs, who have the Licenced Taxi Drivers Association. However, after the data was collected for this study, the same former Uber drivers who brought the case against Uber established an independent union in 2020 (the App drivers and couriers' union) with the aim of representing all UK private hire drivers and couriers, including Uber drivers. This organisation is still at early stages with limited members, and many London Uber drivers are not members. Additionally, in May 2021, Uber and the GMB Union (one of the biggest trade unions in the UK) announced that they had reached an agreement, which means Uber formally recognises the GMB and Uber drivers can now join the GMB (GMB, 2021). Although this is a significant development for Uber drivers in London and the UK, it is unclear what this agreement means for other ridesourcing drivers, who would also benefit from trade union membership and representation.
- The findings from the Uber driver focus groups indicate that ridesourcing drivers would benefit from a strong union that represents the over 40,000 Uber drivers in London (along with other ridesourcing drivers) to work with regulators, policymakers and ridesourcing companies such as Uber to negotiate important issues relating to driver welfare, working hours, rules and responsibilities of drivers and passengers during shared journeys. The union could also assist with mediating disputes relating to complaints against drivers.

The Winners and Losers of Ridesourcing Services

- As with all innovations, there are winners and losers, and in London, Uber appears to be ahead of the transport regulators and has generally benefited from the absence of strict regulations or limitations on its operations (i.e., how many drivers they can have or where in the city they operate). The other main beneficiaries from the introduction of Uber include the tens of thousands of drivers who make a living using the Uber App and commonly acknowledged, during the focus groups, that the flexibility offered by working with the Uber app is one of the main reasons they chose to work with Uber, even though they raised several issues (i.e., welfare, commission, and safety). The findings in this study indicate that users also greatly benefited from Uber services because of the ease of requesting and paying for the service, cheaper fare compared to other for-hire services and the on-demand nature of the service. Moreover, ridesourcing appears to have improved accessibility to some users, including those who did not use for-hire services prior to Uber.

- The findings in this study indicate that ridesourcing service supports the city's transport network during certain situations, such as when there is a tube strike or other problems occur in the main public transport system. However, the main losers appear to be the black cab, minicab, and PT bus operators mainly because they are losing riders to ridesourcing, whilst the transport authorities (i.e., TfL) are finding it challenging to keep up and manage these new services without limiting innovation and development in the transport sector.

Accordingly, there is a need to examine further the broader economic consequences of ridesourcing services, including benefits, disbenefits and the total costs (both monetary and non-monetary) for the city, users, and the drivers and deciding how ridesourcing operators can play their part in reducing any adverse effects for the city's transport system or the society in general.

Impact of Covid on Ridesourcing Services

- The data collection and analysis aspect of this study was completed prior to the COVID-19 global pandemic that started at the end of 2019. However, the pandemic had a considerable effect on transport in general, including ridesourcing service and therefore merited a mention. The Uber services affected the most during the pandemic were the shared services (i.e., Uberpool) because travellers were reluctant to share a ride with strangers and there was requirement to leave a space between passengers. As a result, Uber suspended the Uberpool service in most cities that it operated the shared service, including London, to reduce the chance of spreading the virus.
- Throughout the pandemic, most Uber drivers saw a significant decline in their incomes, and some drivers had to stop work and look for alternative ways of earning an income because of the risk of getting the virus or low demand for the service.

Additionally, many Uber drivers indicated they could not access the UK furlough scheme because they operated as independent contractors and did not fulfil the furlough scheme requirements.

The pandemic has highlighted the need for policymakers, transport authorities and operators to understand more about the medium to long-term effects on travel behaviour and therefore develop measures not only to bring back PT ridership to pre-COVID-19 levels but also address the regulatory gaps (i.e., labour regulations) for gig economy services such as ridesourcing.

Emissions and Congestion Issues

- Uber in the UK has announced a fund for supporting drivers to transition to zero-emission vehicles as part of their 'Clean Air Plan' in London, which aims to have a fully electric ridesourcing fleet by 2025 in London and across the UK by 2030 (see Uber, 2021). The fund allows drivers to apply for electric vehicle purchase or lease assistance and aims to support London's goals in reducing emissions from the transport sector and improving air quality. As part of a broader incentive programme, Uber has partnered with vehicle manufactures such as Nissan and Hyundai to offer discounts (on purchase or lease) to Uber drivers on new electric vehicles whilst also developing discounts on home chargers. Moreover, Uber in London has recently added a new option to their application that allows users to request an UberX ride using an electric vehicle. This initiative will help deal with the road transport-related pollution problems in London. Therefore, contributing to the broader 'net zero' ambitions; however, the current uptake by drivers and whether there will be sufficient charging infrastructure is not known (particularly for drivers who are unable to have home chargers), and electrification of the Uber fleet will not help with ongoing congestion challenges.
- The introduction of the congestion charge liability for ridesourcing services in 2020 has impacted the drivers' earnings since they must pay the fee and are unable to pass on the charges to the users because the trip fares are set by Uber, not the drivers, which means some drivers might have to work extra hours to meet their daily targets.

Despite the recent developments explained in this section, the main points that might change some of the data collected from the focus group sessions would be the supreme court ruling that classified all Uber drivers as Uber employees and the establishment of a union for ridesourcing drivers. These would help resolve concerns from the drivers regarding welfare issues and the lack of representation. However, the core empirical data for this study is unaffected by these developments, and therefore the findings of the study are deemed valid and can be consulted by policymakers, transport authorities, PT operators and researchers.

8.3.2 Recommendations

At the time of collecting the research data, this was the first study that investigated the use of shared (Uberpool) and non-shared (UberX) ridesourcing services and its relationship with PT in the UK, using empirical data from users, drivers, policymakers, transport authorities, PT operators, ridesourcing service and industry experts. It was important to obtain insights and empirical evidence on the possible consequences of ridesourcing services for traditional PT modes and how they were used, by who, why and for what trip purposes in London. Therefore, the contribution of this study includes providing the first empirical data on shared and non-shared ridesourcing services in the UK, which helps to understand how these services are used, the user socio-demographic, and the trip characteristics of the two services. Moreover, the findings offer important insights into the implications of ridesourcing services for traditional PT, active mode, and the influencing factors on why users adopt ridesourcing. Although some of the data collected during this study were new and therefore not found in previous research (e.g., policymakers, stakeholders and drivers' views were not generally covered), there were some similarities to earlier research undertaken in North America, including results on the socio-demographic of user and trip characteristics. Thus, earlier research on ridesourcing would still be relevant because research on this topic in the UK is still limited. The results from the interviews, focus groups and user surveys in London are deemed novel and substantial, therefore can be generalised for other cities in the UK or Europe with similar PT, trip making and urban structure, and may be used by policymakers and transport authorities when developing new ridesourcing policies and regulations.

Accordingly, based on the findings from this study, the following recommendations are made, and are intended for transport policymakers and regulators, transport authorities, and PT operators.

1. Integrating with other Modes

The need to develop guidelines for use by PT operators and ridesourcing service providers is recognised from the findings, to enable better integration between ridesourcing and PT modes, and, therefore, help achieve London's transport objectives. This should include guidance for PT bus operators on how they can make better use of shared ridesourcing to fill some gaps in the network or provide services in low demand peripheral areas. In addition to integrating payment systems and developing guidance for ridesourcing providers like Uber, on ways they can support the main PT system, emphasising encouraging and perhaps incentivising them to prioritise shared ridesourcing. For example, the majority (i.e., over 90%) of Uberpool and UberX users indicated they owned an Oyster card; therefore, ridesourcing payment methods should be integrated with the TfL Oyster card so that passengers who have transferred to/from shared ridesourcing (such as Uberpool) onto the PT network (in specified areas or timings) could receive a discounted fare. The amount of discount and where/when should be determined between TfL and ridesourcing service providers. This could further be extended to include specific user groups, or situations when there is a problem with the PT network (i.e., during tube strikes).

2. Collecting Ridesourcing Data

The lack of ridesourcing service data remains an issue for policymakers and transport authorities, as highlighted in Chapters 2 and 5 of this thesis. Therefore, it is recommended that transport authorities such as TfL develop data collection and monitoring mechanisms for ridesourcing services to understand exactly how these services function within the city and thus develop evidence-based policy measures and regulations. For example, the ridesourcing data could involve agreements with service providers, such as Uber, to provide regular anonymised data to TfL as part of their licencing agreements (this would have to apply to all ridesourcing providers). Alternatively, transport authorities could establish periodic data collection as part of the existing national or travel surveys conducted by the DfT, or the London travel demand survey undertaken by TfL. Recognising the importance of collecting transport data, the DfT launched a consultation paper in 2020 on regulating various road transport modes in the future to see how these modes should be regulated to achieve a flexible and future proof regulatory environment for the transport sector. Key suggestions from the consultation included collecting anonymised data in real-time from mobility services, including buses, taxis and PHVs, and possibly making it mandatory for operators to share data. In addition, issues on data privacy, standardisation, and mechanisms for collecting and sharing data were highlighted during the consultation (DfT, 2020). Understandably, there will be privacy and data protection issues to overcome, so the data from ridesourcing companies - which could include geo-location, trip, and occupancy data - should be anonymised and encrypted according to prevailing legislation. This effort requires close cooperation between ridesourcing operators and transport authorities but should be led and facilitated by TfL as the ultimate transport body for London.

3. Policy and Governance

The findings from this study show the use of Uber services is widespread, well-liked by the users, and they serve a significant number of trips within London; therefore, it is recommended that transport authorities develop specific policies for ridesourcing and particularly for the shared ridesourcing options, so as not to deter these types of services but instead manage and integrate them into the city's transport system.

The development process should involve input from all important stakeholders, including policymakers and regulators, transport authorities, service providers, PT operators and representatives from users and drivers. This will help resolve issues related to the lack of collaboration and ensure viewpoints from all stakeholders are considered. In addition, such new policies should address issues of integration with other modes; how the public and private sectors work together to provide such services and reducing emissions from ridesourcing vehicles.

London aims to achieve 80% of all trips in the city to be made using PT or active modes by 2041 and has set targets to reduce emissions, which offers an opportunity for policymakers to consider the role of new shared ridesourcing services (e.g., Uberpool) in achieving these ambitious targets, without negatively affecting the primary PT or active modes targets. Policymakers and transport authorities should develop incentives, such as reduced congestion charge levies on shared services and zero-emission vehicles, off-peak trips, trips that serve areas with limited PT coverage and those that serve the elderly and disabled user groups. The authorities should also provide pick-up and drop-off areas near PT hubs and stations to facilitate first/last mile trips and encourage collaboration between the ridesourcing companies, transport operators and transport authorities.

4. Ridesourcing Regulations

The Uber surveys show that over 17% of Uberpool and UberX users were using black cab or minicab services before they started using Uber for the same or similar trips, and they chose Uber because it was cheaper and more convenient. In addition, Uberpool was considered more environmentally friendly, and users thought it helps to reduce traffic congestion. These findings reveal ridesourcing services are affecting the black cab and minicab services in London because of their convenience, cheaper fare and available fleet size compared to the other for-hire services. Besides, there are no specific regulations covering ridesourcing in London at present, and the services currently operate under the PHV regulations, which even the regulators admit needs an overhaul. Accordingly, the development of new ridesourcing regulations is recommended, perhaps as part of an updated PHV regulation, which should provide classifications of different service types, how they are provided in a different context, for example, greater flexibility could be given to service providers in suburban areas compared to urban areas that are well served by PT modes.

The new regulations should address driver standards, driver welfare, including maximum working hours without breaks, and define clear responsibilities for all those who are involved in providing ridesourcing. For example, with shared ridesourcing (i.e., Uberpool), responsibilities need to be clarified when incidents occur between two/three passengers (poolers) and what the driver should do in such cases. Moreover, new regulations should be developed in coordination with key stakeholders and should be established to maximise the opportunities offered by ridesourcing services whilst addressing the existing regulatory gaps in the taxi and PHV legislation.

Addressing Transport Authority Capacity Challenges

The discussions from the interviews revealed a wide gap between internal organisational capacities at transport agencies (i.e., the regulation, transport planning and taxi/PHV departments) and the challenges from new disruptive transport innovations such as ridesourcing. Therefore, to bridge that gap and better equip the transport agencies to deal with these new challenges, it is recommended that transport authorities and regulators (such as TfL) improve their internal organisational capabilities to enable them to manage, regulate and work with ridesourcing services. This should involve closer cooperation across sectors, including working with innovators, industry experts, and ridesourcing service providers when devising training and capacity building activities. For example, in 2020, the DfT issued statutory guidance that required licensing authorities to consult if there was a need to install CCTV in PHVs and taxis and whether it would positively or negatively affect passengers' safety. As a result, TfL conducted a public consultation on whether CCTV should be installed in taxis and PHVs in London (including ridesourcing) as a mandatory requirement or if they should leave that to owners to decide. This was an opportunity for regulators and policymakers to work closely with those involved in providing these new services as any possible mandatory requirement like this needs to consider the perspectives of all involved. Accordingly, the transport authorities should adopt a collaborative approach and work closely with key stakeholders, including research bodies on pilots and R&D initiatives, that evaluate the viability and suitability of new mobility services and help inform new policy measures.

The policymakers and transport authorities in London may use the findings of this study to develop specific policy measures, regulations, and guidelines for managing the consequences of ridesourcing services to the city's transport system. The effects of ridesourcing may vary depending on the city context in terms of size, densities, and level of available PT modes. Therefore, the necessary policy interventions are likely to vary; however, cities with similar travel and transport features to London may benefit from the findings and recommendations of this study.

8.4 Limitations and Future Study

Limitations

Although valuable new data and insights have been offered, as with other studies of this nature, the following limitations are identified for this study.

- Interviews have some limitations in terms of independent verification (i.e., researcher has no choice but to take at face value what the interviewees say) and potential for biases such as selective memory, self-attribution, and possible exaggeration. Moreover, interviews were only conducted with those who accepted the invitations. Although interviews were held with representatives from all the key stakeholders in London, several senior management staff could not participate, and organisations such as ComoUK could not take part in the research.

- The issue of limited data availability remains a significant barrier in understanding ridesourcing in London. The transport authorities and PT operators in London did not collect any ridesourcing service data, and Uber refused to share any trip usage data, which made it difficult to verify the representativeness of the survey data.
- The survey data collected was limited to passengers who were using Uberpool and UberX services, so other Uber services and other ridesourcing services such as Addison Lee and Via were not covered in this study. Moreover, collecting the survey data relied on the Uber drivers complying with the research instructions and offering the survey to all the passengers without bias.
- Focus group participants were limited to 28 Uber drivers who volunteered to partake in the research. However, there were no female drivers or part-time drivers due to difficulties in recruiting participants from these two groups; thus, the perspectives of female London Uber drivers and those that worked part-time might have been missed.
- The case study geographical coverage was limited to the Greater London area; therefore, the study did not cover smaller cities with different transport demand and accessibility challenges.

Future Study

Considering this study's aims and limitations identified, several opportunities for future research are suggested as presented below.

- This study collected user survey data whilst passengers were making the trip; therefore, future research is needed to understand inequalities in accessing and using ridesourcing services, particularly for the elderly and those who do not have access to the internet or smartphones.
- The findings indicated that some passengers might be using Uberpool to connect to main PT modes; however, since sufficient data on this was not obtained in this research, further investigations are needed to clarify the role of Uberpool services in fulfilling first and last-mile trips. This can involve surveying PT users to understand how often they used shared ridesourcing to connect with PT modes such as the tube, trains, or buses.

- The study can be expanded to include larger sample size and other ridesourcing operators, including those that operate in other UK cities, to understand how the results would contrast with Uber services in London. Moreover, this can include other ridesourcing services such as Uber Access, Uber Lux and UberX electric vehicles.
- This study investigated the use of ridesourcing services and its relationship with PT. Therefore, further research can be conducted to investigate the effects of all ridesourcing services on traffic congestion in London, particularly in central London during different times of the day. This would require detailed trip data or tracking of ridesourcing vehicles during operating hours. Partnerships could be established with TfL to collect the necessary data, or APIs may be obtained from ridesourcing service providers as part of future data collection and monitoring systems.
- Several significant factors that influenced users' choice of Uberpool instead of PT, active modes and Uber or taxi were identified in this study. Accordingly, with the use of supplementary data, simulation models could be developed to further investigate and predict the mode choice of ridesourcing users considering all the key influencing factors.
- Further studies are needed to examine and quantify the broader economic implications of ridesourcing services, including benefits, disbenefits and the total costs of these services for the city, users, and the drivers. This needs sensitive financial information (i.e., income, and tax data), so compliance with prevailing privacy and data protection legislation is required. Also, close coordination with ridesourcing service providers, labour unions, transport authorities and other relevant authorities is needed.

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Appendix A: Consent forms for interviews and focus groups

This section presents the consent forms used for the interviews and focus groups.

Figure 6. Interviews and focus groups consent form

Edinburgh Napier UNIVERSITY

Research informed Consent form

Research Title: Impact of Ridesourcing Services on Public Transport

Edinburgh Napier University requires that all persons who participate in research studies give their written consent to do so. **Please read the following and sign it** if you agree with what it says.

1. I freely and voluntarily consent to be a participant in the research project on the topic of [Impact of Ridesourcing Services on Public Transport] to be conducted by [Mohamed Jama Mohamed], who is a PhD Researcher at the Transport Research Institute, Edinburgh Napier University, Scotland, U.K.
2. The broad goal of this research study is to understand the Impact of Ridesourcing Services on Public Transport, in terms of policy, operations and management. Specifically, I have been asked to participate in an interview or focus group session, which should take no longer than 30mins to complete.
3. I have been told that my responses will be anonymised. My name will not be linked with the research materials, and I will not be identified or identifiable in any report subsequently produced by the researcher.
4. I also understand that if at any time during the Interview / Focus Group I feel unable or unwilling to continue, I am free to leave. That is, my participation in this study is completely voluntary, and I may withdraw from it without negative consequences. However, after data has been anonymized or after publication of results it will not be possible for my data to be removed as it would be untraceable at this point.
5. In addition, should I not wish to answer any particular question or questions, I am free to decline.
6. I have been advised the interview / focus group will be audio recorded and the recordings will be saved in researcher's equipment and will be discarded after completion of research.
7. I have been given the opportunity to ask questions regarding the interview / focus group and procedure and my questions have been answered to my satisfaction.
8. I have read and understand the above and consent to participate in this study. My signature is not a waiver of any legal rights. Furthermore, I understand that I will be able to keep a copy of the informed consent form for my records.

Participant's Signature   Date

I have explained and defined in detail the research procedure in which the respondent has consented to participate. Furthermore, I will retain one copy of the informed consent form for my records.

Researcher's Signature   Date

Appendix B: Uber user survey questionnaire

This section provides the survey questionnaire templates used to collect data from UberX and Uberpool users in London.

Figure 7: Uberpool user survey questionnaire (p1 of 2)

FOR UberPOOL USERS ONLY

Survey Questions (page 1 of 2)

(Q1) What is the **purpose** of your trip, today? **(Tick only one)**

☐ Going to work ☐ Going to social event/activity
☐ Going Home ☐ Going to Airport
☐ Going Shopping ☐ Going to School/College/University
☐ Visiting family/friends ☐ Doing family errands (i.e. GP)
☐ Going to Public Transport station (i.e. Bus, Train, Tram, Tube)
☐ Other *(please specify)* ____________

(Q2) For what type of trip/journey do you **normally** use UberPOOL? **(Tick all that apply)**

☐ To/from work ☐ To visit family/friends
☐ To/from Shopping ☐ To/from social events/activities
☐ To/from Public transport station/stop ☐ To/from Airport
☐ To/from School/College/University
☐ Other *(please specify)* ____________

(Q3) Where did your UberPOOL trip **start** today?

☐ At home ☐ Public Transport station
☐ Office/workplace ☐ Family or friends place
☐ At social event/activity (i.e. gym, bar etc.) ☐ Airport
☐ Other *(please specify)* ____________

(Q4) How many other UberPOOL users have **shared** the vehicle with you today on this trip?

☐ None - I am alone ☐ 1 other UberPOOL passenger
☐ 2 or more other UberPOOL passengers

(Q5) How much do you agree with the below statement? **Use the below scale to indicate.**

	Strongly Agree	Agree	Undecided /Neutral	Disagree	Strongly Disagree
I have no problem, if the driver diverts to pick-up/drop-off another passenger along the same route.					

(Q6) When did you **start** using **UberPOOL?**

☐ This is my first time ☐ For about the last month
☐ For about the last 6 months ☐ For **more** than 6 months

(Q7) How often do you **use** UberPOOL during the following times? **(Tick only one for each period)**

	Always	Often	Some -times	Rarely	Never
At night *(8pm - 5am)*					
During weekends					
Week days: Early morning (5am - 9am) or late evening (6pm - 9pm)					
Week days (Mon - Fri 9am-5pm)					
During holiday breaks					

(Q8) Which of the following do you **use the most** to get around London? **(Tick only one for each option).**

	Always	Often	Some -times	Rarely	Never
Personal Car - as a driver					
Car as Passenger					
Car-clubs (e.g. Zip car)					
Ridesourcing (e.g. Uber)					
Public Transport (Bus/Tube/Train)					
Taxi (i.e. minicab or black-cab)					
Cycle					
Walk					

(Q9) What is the estimated cost of your UberPOOL trip today? **(Please write in below)**

Trip cost: £ ________

(Q10) On average how much do you **save** per trip by using UberPOOL instead of normal UberX?

☐ Less than 4% ☐ 21% to 30%
☐ 5% to 10% ☐ More than 35%
☐ 11% to 20% ☐ I don't use UberX / I Don't know

(Q11) Why did you **use UberPOOL** today instead of **Public Transport** options such as Tube, Train and Bus? **(indicate by marking only one for each reason.)**

	Strongly Agree	Agree	Undecided /Neutral	Disagree	Strongly Disagree	Unable to rate
It is Cheaper						
It is Quicker						
It is Safer						
It is more comfortable to travel by Car						
Door to Door service						
Ease of requesting the service and payment						
There is no public transport stop or station near my origin/destination						

Figure 7. Uberpool user survey questionnaire (p2 of 2)

Survey Questions (page 2 of 2)

(Q12) If this is not your first time using UberPOOL, How often do you use the service? **(Tick only one that is applicable)**

- ☐ Twice or more times daily
- ☐ At least once everyday
- ☐ 2-4 times a week
- ☐ Once or twice a week
- ☐ Once or twice a month
- ☐ Less than once a week
- ☐ Occasionally (i.e. 2-3 times a yr.)
- ☐ Less than once a month
- ☐ Other *(please specify)* ______________________________

(Q13) How many times have you used **any Uber service** *(UberX, UberPOOL, Exec etc.)* in the last month? **(Please *specify* in below box.)**

I have used Uber services { ____________ } times in the last Month

(Q14) If UberPOOL were not available, what other transport mode would you **most likely use** for this same trip? **(indicate by marking only one for each option.)**

	Always	Likely	Maybe /Neutral	Unlikely	Never
Drive a car alone					
Get a lift from family/friend					
Use Car-club (e.g. Zip Car)					
Use non-shared service (i.e. **Uber** /Lyft)					
Use the **Tube**, **Train** or **Tram**					
Use Public Transport **Bus**					
Use a Taxi (minicab / Black-cab)					
Cycle					
Walk					
Not make this trip					

(Q15) What transport option (mode) did you use the **MOST** for the same journeys before you started using UberPOOL? **(Choose only one option)**

- ☐ Drive a car alone
- ☐ Use public transport **Bus**
- ☐ Get a lift from family/friend
- ☐ Use a Taxi (minicab / Black-cab)
- ☐ Use Car-club (e.g. Zip Car)
- ☐ Cycle
- ☐ Use the **Tube, Train** or **Tram**
- ☐ Walk
- ☐ I did not make the same trips before
- ☐ Other *(please specify)* ______________________________

(Q16) Would you **still use UberPOOL,** if you had **better** access to public transport options *(e.g. Bus, Train, Tram, Tube)*?

- ☐ Yes
- ☐ No
- ☐ Only during bad weather
- ☐ Only for certain Journeys (such a Shopping, evenings/late-night or airport trips)

(Q17) How would you rate the UberPOOL service?

(Use this scale to rate the service: 1 = Very Poor and 5 = Excellent)	1	2	3	4	5
Tick (✓) one only ➔					

Please comment why you chose that rating: ______________________________

____

(Q18) Why did you **use UberPOOL** today instead of **Walking or Cycling**? **(indicate by marking only one for each reason.)**

	Strongly Agree	Agree	Undecided /Neutral	Disagree	Strongly Disagree	Unable to rate
It is Quicker						
It is Safer						
It is more comfortable to travel by Car						
It is too far to walk or cycle						
Due to ease of requesting & paying for Uber						
I don't have access to a bike						
I am unable to walk far or cycle (i.e. having physical constrain)						

(Q19) What are the **reasons for using UberPOOL** compared to standard **UberX or Taxi service** (e.g. minicab/black-cab)? **(Tick top THREE that mostly apply)**

- ☐ It is cheaper
- ☐ It is safer
- ☐ It is quicker
- ☐ It is more environmentally friendly
- ☐ I want to meet people during trip
- ☐ I want to help reduce traffic congestion
- ☐ Other *(please specify)* ______________________________

(Q20) Do you have a driver's license?

- ☐ **Yes**
- ☐ **No** *(If no skip to Question Q23)*

(Q21) Do you currently own a car?

- ☐ Yes
- ☐ No

(Q22) Did you own a car before you starting using UberPOOL services?

- ☐ Yes
- ☐ No

(Q23) Do you own an **Oyster / Travel card** to use for public transport?

- ☐ Yes
- ☐ No

(Q24) How much **effect** does **UberPOOL** or similar services have, on your need to own a Car?

	Very high effect	Some effect	Neutral	Very little effect	No effect
Effect of UberPOOL services on your need to own a car (Please tick ✓) ➔					

(Q25) Are you a **Visitor** or **Resident** of London?

- ☐ I live in London
- ☐ I am visiting London

(Q26) What is your **employment status**?

- ☐ I am Employed / Self Employed
- ☐ I am Unemployed
- ☐ I am a Student
- ☐ I am Retired

(Q27) What is your age group?

- ☐ 18-25
- ☐ 41-45
- ☐ 26-30
- ☐ 46-50
- ☐ 31-35
- ☐ 51-55
- ☐ 36-40
- ☐ 56 or over

(Q28) What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other

(Q29) What is your highest level of education completed?

- ☐ Primary School
- ☐ Secondary School
- ☐ College
- ☐ Undergraduate
- ☐ Postgraduate

Figure 8: UberX user survey questionnaire (p1 of 2)

FOR Uber-X USERS ONLY

Survey Questions (page 1 of 2)

(Q1) What is the **purpose** of your journey today? **(Tick only one)**

- ☐ Going to work
- ☐ Going to social event/activity
- ☐ Going Home
- ☐ Going to Airport
- ☐ Going Shopping
- ☐ Going to School/College/University
- ☐ Visiting family/friends
- ☐ Doing family errands (i.e. GP)
- ☐ Going to Public Transport station (i.e. Bus, Train, Tram, Tube)
- ☐ Other *(please specify)* ____________________

(Q2) For what type of trip/journey do you **normally** use UberX? **(Tick all that apply)**

- ☐ To/from work
- ☐ To visit family/friends
- ☐ To/from Shopping
- ☐ To/from social events/activities
- ☐ To/from Public transport station/stop
- ☐ To/from Airport
- ☐ To/from School/College/University
- ☐ Other *(please specify)* ____________________

(Q3) Where did your UberX trip **start** today?

- ☐ At home
- ☐ Public Transport station
- ☐ Office/workplace
- ☐ Family or friends place
- ☐ At social event/activity (i.e. gym, bar etc.)
- ☐ Airport
- ☐ Other *(please specify)* ____________________

(Q4) When did you **start** using **UberX** services?

- ☐ This is my first time
- ☐ For about the last month
- ☐ For about the last 6 months
- ☐ For **more** than 6 months

(Q5) How often do you **use** UberX during the following times?
(Tick only one for each period)

	Always	Often	Some -times	Rarely	Never
At night *(8pm - 5am)*					
During weekends					
Week days: Early morning (*5am - 9am*) or late evening (*6pm - 9pm*)					
Week days (*Mon - Fri 9am-5pm*)					
During public holidays					

(Q6) Which of the following do you **use the most** to get around London?
(Tick only one for each option).

	Always	Often	Some -times	Rarely	Never
Personal Car - as a driver					
Car as Passenger					
Car-clubs (e.g. Zip car)					
Ridesourcing (e.g. Uber)					
Public Transport (Bus/Tube/Train)					
Taxi (i.e. minicab or black-cab)					
Cycle					
Walk					

(Q7) What is the cost of your UberX trip today? **(Please write in below)**

Trip cost: £ ____________

(Q8) What are your **reasons for using UberX** instead of **UberPOOL?**
(Tick top THREE answers that mostly apply)

- ☐ It is safer
- ☐ For privacy reasons
- ☐ It is quicker
- ☐ I don't want any delays during trip
- ☐ I don't want to share with strangers
- ☐ Other *(please specify)* ____________________

(Q9) What are the **reasons for using UberX** compared to standard **Taxi services** (e.g. minicab or black-cab)? **(Tick top THREE that mostly apply)**

- ☐ It is cheaper
- ☐ It is safer
- ☐ It is quicker
- ☐ It is more environmentally friendly
- ☐ Easier to **use** and **pay** by Uber App
- ☐ Less waiting time compared to taxi services
- ☐ Other *(please specify)* ____________________

(Q10) Why did you use **UberX** today instead of **Public Transport** options such as Tube, Train and Bus? **(indicate by marking only one for each reason.)**

	Strongly Agree	Agree	Undecided /Neutral	Disagree	Strongly Disagree	Unable to rate
It is Cheaper						
It is Quicker						
It is Safer						
It is more comfortable to travel by Car						
Door to Door service						
Ease of requesting the service and payment						
There is no public transport stop or station near my origin/destination						

Figure 8. UberX user survey questionnaire (p2 of 2)

Survey Questions (page 2 of 2)

(Q11) If this is not your first time using **UberX service**, How often do you use the service?
(Tick only <u>one</u> that is applicable)

☐ Twice or more times daily	☐ At least once everyday
☐ 2-4 times a week	☐ Once or twice a week
☐ Once or twice a month	☐ Less than once a week
☐ Occasionally (i.e. 2-3 times a yr.)	☐ Less than once a month
☐ Other *(please specify)* ______________________________	

(Q12) How many times have you used any UberX service in the last month?
(Please *specify* in below box.)

I have used UberX services { ___________ } times in the last Month

(Q13) If **UberX** were not available, what other transport mode would you **most likely use** for this same trip? **(indicate by marking only one for each option.)**

	Always	Likely	Maybe /Neutral	Unlikely	Never
Drive a car alone					
Get a lift from family/friend					
Use Car-club (e.g. Zip Car)					
Use shared service (i.e. **UberPOOL**)					
Use the **Tube**, **Train** or **Tram** services					
Use Public Transport **Bus**					
Use a Taxi (minicab / Black-cab)					
Cycle					
Walk					
Not make this trip					

(Q14) What transport option (mode) did you use the **MOST** for the same journeys before you started using **UberX**? **(Choose only one option)**

☐ Drive a car alone	☐ Use Public Transport **Bus**
☐ Get a lift from family/friend	☐ Use a Taxi (minicab / Black-cab)
☐ Use Car-club (e.g. Zip Car)	☐ Cycle
☐ Use the **Tube**, **Train** or **Tram**	☐ Walk
☐ I **did not** make the same trips	
☐ Other *(please specify)* ______________________________	

(Q15) Would you **still use UberX,** If you had **better** access to public transport options *(e.g. Bus, Train, Tram, Tube)*?

☐ Yes	☐ No
☐ Only during bad weather	
☐ Only for certain Journeys (such a Shopping, evenings/late-night or airport trips)	

(Q16) How would you rate the UberX service?

(Use this scale to rate the service: 1 = Very Poor and 5 = Excellent)	1	2	3	4	5
Tick (✓) one only ➔					

Please comment why you chose that rating: ______________________________
____

(Q17) Why did you use **UberX** today instead of **Walking or Cycling**?
(indicate by marking only <u>one</u> for each reason.)

	Strongly Agree	Agree	Undecided /Neutral	Disagree	Strongly Disagree	Unable to rate
It is Quicker						
It is Safer						
It is more comfortable to travel by Car						
It is too far to walk or cycle						
Due to ease of requesting & paying for Uber						
I don't have access to a bike						
I am unable to walk far or cycle (i.e. having physical constrain)						

(Q18) Do you have a driver's license?

☐ Yes ☐ No ***(If no skip to Question Q21)***

(Q19) Do you currently own a car?

☐ Yes ☐ No

(Q20) Did you own a car before you starting using UberX services?

☐ Yes ☐ No

(Q21) Do you own an **Oyster / Travel card** to use for public transport?

☐ Yes ☐ No

(Q22) How much effect does **UberX or similar services** have on your need to own a Car?

	Very high effect	Some effect	Neutral	Very little effect	No effect
Effect of UberX services on your need to own a car (**please tick ✓**) ➔					

(Q23) Are you a **Visitor** or **Resident** of London?

☐ I live in London ☐ I am visiting London

(Q24) What is your **employment status**?

☐ I am Employed / Self Employed	☐ I am Unemployed
☐ I am a Student	☐ I am Retired

(Q25) What is your age group?

☐ 18-25	☐ 41-45
☐ 26-30	☐ 46-50
☐ 31-35	☐ 51-55
☐ 36-40	☐ 56 or over

(Q26) What is your gender?

☐ Male ☐ Female ☐ Other

(Q27) What is your highest level of education completed?

☐ Primary School	☐ Secondary School	☐ College
☐ Undergraduate	☐ Postgraduate	☐ None

Appendix C: Descriptive analysis results for all variables

Descriptive statistical analyses were conducted for all variables (questions) from the UberX and Uberpool user survey. The descriptive analysis results provided in this section include the frequencies, percentages for each variable.

Table 30. Journey/Trip purpose (Q1-UberX/Uberpool)

Trip Purpose	UberX (*n* = 449)		Uberpool (*n* = 457)	
	Frequency	Percentage	Frequency	Percentage
Going Home	132	29.4%	76	16.6%
Going to School/Work	113	25.2%	135	29.5%
Going to PT station/stop	11	2.4%	93	20.4%
Social Event	61	13.6%	65	14.2%
Visit Friends/Family	57	12.7%	26	5.7%
Errands/Shopping	28	6.2%	47	10.3%
Airport	35	7.8%	13	2.8%
Other	12	2.7%	2	0.4%
UberX vs. Uberpool	χ2 (df)		*P*-Value	
	115.37		0.000	

Table 31. Type of trip/journey normally used for UberX/Uberpool (Q2-Uber/Uberpool)

Normal Trip	UberX (*n* = 450)		Uberpool (*n* = 457)		UberX vs. Uberpool	
	Frequency	Percentage	Frequency	Percentage	χ2 (df)	*P*-Value
To/From Social Activities	267	59.3%	380	83.2%	62.90	0.000
Visit Friends/Family	177	39.3%	293	64.1%	55.77	0.000
To/From Work	155	34.4%	130	28.4%	3.785	0.052
To/From PT station/stop	55	12.2%	169	37.0%	74.73	0.000
To/From Airport	133	29.6%	73	16.0%	23.83	0.000
To/From Shopping	68	15.1%	80	17.5%	0.952	0.329
To/From School	28	6.2%	48	10.5%	5.41	0.020
Other	17	3.6%	6	1.3%		

Table 32. Trip origin (Q3-UberX/Uberpool)

Trip Origin	UberX (*n* = 448)		Uberpool (*n* = 457)	
	Frequency	Percentage	Frequency	Percentage
At Home	225	50.2%	206	45.1%
At Social Event/Activity	73	16.3%	89	19.5%
Family/Friend's Place	44	9.8%	63	13.8%
PT Stop/Station	26	5.8%	54	11.8%
Office/Workplace	44	9.8%	23	5.0%
Other	21	4.7%	21	4.6%
Airport	15	3.3%	1	0.2%
UberX vs. Uberpool	*χ2 (df)*		*P-Value*	
	34.34		*0.000*	

Table 33. How long the service was used (Q4 UberX & Q6 Uberpool)

How long they used the Service	UberX (*n* = 449)		Uberpool (*n* = 452)	
	Frequency	Percentage	Frequency	Percentage
For more than 6 months	286	63.7%	208	45.5%
For about the last month	55	12.2%	145	32.1%
For about the last 6 months	70	15.6%	70	15.5%
This is my first time	38	8.5%	29	6.4%
UberX vs. Uberpool	*χ2 (df):*		*P-Value:*	
	54.02		*0.000*	

Table 34. Number of other Uberpool users during trip (Q4 Uberpool)

Number of Other Users (*n* = 455)	Frequency	Percentage
One other Uberpool passenger	241	53.0%
Two or more other Uberpool passengers	85	18.7%
None – I am alone	129	28.4%

Table 35. Any objection if driver diverts to drop-off/pick-up other passengers (Q5 Uberpool)

I have no problem if the driver diverts to pick-up/drop-off another passenger along the same route."	Frequency (n = 449)	Percentage
Strongly Disagree	15	3.3%
Disagree	44	9.8%
Undecided/Neutral	114	25.4%
Agree	215	47.9%
Strongly Agree	61	13.6%

Table 36. Frequency of use during different periods (Q5 UberX & Q7 Uberpool)

Frequency of Use	UberX		Uberpool		UberX vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
1. At Night (8pm-5am)	*n* = 433		*n* = 455		0.687
Never	19	4.4%%	21	4.6%	
Rarely	31	7.2%	21	4.6%	
Sometimes	163	37.6%	156	34.3%	
Often	124	28.6%	179	39.3%	
Always	96	22.2%	78	17.1%	
2. During Weekends	*n* = 425		*n* = 451		0.381
Never	17	4.0%	13	2.9%	
Rarely	37	8.7%	25	5.5%	
Sometimes	167	39.3%	195	43.2%	
Often	172	40.5%	187	41.5%	
Always	32	7.5%	31	6.9%	
3. *During Weekdays: (Early Morning 5am-9am/ Late Evening 6am-9pm)*	*n* = 424		*n* = 453		0.981
Never	34	8.0%	29	6.4%	
Rarely	92	21.7%	108	23.8%	
Sometimes	192	45.3%	197	43.5%	
Often	77	18.2%	98	21.6%	
Always	29	6.8%	21	4.6%	
4. *During Weekdays. (Mon – Fri 9am-5pm)*	*n* = 421		*n* = 451		0.063
Never	48	11.4%	49	10.9%	
Rarely	123	29.2%	156	34.6%	
Sometimes	148	35.2%	154	34.1%	
Often	68	16.2%	78	17.3%	
Always	34	8.1%	14	3.1%	

Table 36. Frequency of use during different periods (Q5 UberX & Q7 Uberpool) (Continued)

Frequency of Use	UberX		Uberpool		UberX vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
5. During Public Holidays	*n* = 420		*n* = 449		0.000
Never	75	17.9%	105	23.4%	
Rarely	117	27.9%	184	41.0%	
Sometimes	139	33.1%	108	24.1%	
Often	60	14.3%	36	8.0%	
Always	29	6.9%	16	3.6%	

Table 37. Transport modes used the MOST to get around London (Q6 UberX & Q8 Uberpool)

Mode of transport used the MOST	UberX		Uberpool		UberX vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
1. Personal Car – As Driver	*n* = 432		*n* = 450		0.000
Never	154	35.6%	218	48.4%	
Rarely	98	22.7%	131	29.1%	
Sometimes	74	17.1%	37	8.2%	
Often	33	7.3%	28	6.2%	
Always	73	16.2%	36	8.0%	
2. Personal Car (As a passenger)	*n* = 431		*n* = 451		0.000
Never	66	14.7%	19	4.2%	
Rarely	84	19.5%	51	11.3%	
Sometimes	172	39.9%	289	64.1%	
Often	95	22.0%	81	18.0%	
Always	14	3.2%	11	2.4%	
3. Car Clubs	*n* = 422		*n* = 446		0.385
Never	207	49.1%	222	49.8%	
Rarely	89	21.1%	122	27.4%	
Sometimes	106	25.1%	76	17.0%	
Often	16	3.8%	18	4.0%	
Always	4	0.9%	8	1.8%	

Table 37. (continued)					
4. Ridesourcing	*n* = 429		*n* = 450		0.000
Never	16	3.7%	9	2.0%	
Rarely	45	10.5%	11	2.4%	
Sometimes	168	39.2%	116	25.8%	
Often	162	37.8%	242	53.8%	
Always	38	8.9%	72	16.0%	
5. *Public Transport*	*n* = 441		*n* = 454		0.000
Never	11	2.5%	5	1.1%	
Rarely	19	4.3%	12	2.6%	
Sometimes	104	23.6%	55	12.1%	
Often	189	42.9%	194	42.7%	
Always	118	26.8%	188	41.1%	

Table 38. Transport modes used the MOST to get around London (Q6 UberX & Q8 Uberpool) (continued)

Mode of transport used the MOST	UberX		Uberpool		UberX vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
6. Taxi	*n* = 432		*n* = 451		0.054
Never	82	19.0%	117	25.9%	
Rarely	158	36.6%	172	38.1%	
Sometimes	121	28.0%	82	18.2%	
Often	60	13.9%	67	14.9%	
Always	11	2,5%	13	2.9%	
7. Cycle	*n* = 422		*n* = 444		0.425
Never	157	37.2%	139	31.3%	
Rarely	115	27.3%	149	33.6%	
Sometimes	85	20.1%	83	18.7%	
Often	46	10.9%	54	12.2%	
Always	19	4.5%	19	4.3%	
8. Walk	*n* = 433		*n* = 451		0.000
Never	37	8.5%	27	6.0%	
Rarely	47	10.9%	20	4.4%	
Sometimes	98	22.6%	46	10.2%	
Often	160	37.0%	176	39.0%	
Always	91	21.0%	182	40.4%	

Table 39. Trip Cost (£) (Q7 UberX & Q9 Uberpool)

Service	Range	Median	Mean	*p*-value
UberX	£0 - £110.00	£13.00	£17.28	0.000
Uberpool	£0 - £75.00	£9.00	£11.03	

Table 40. Average fare savings by Uberpool users compared to UberX (Q10 Uberpool only)

Reported average fare savings	Frequency (n = 438)	Percentage
Less than 4%	22	5.0%
5% to 10%	41	9.4%
11% to 20%	71	16.2%
21% to 30%	179	40.9%
More than 35%	105	24.0%
I don't use UberX/I don't know	20	4.6%

Table 41. Reasons for using UberX instead of Uberpool (Q8 UberX Users Only)

Responses	1st Reason (*n* = 445)		2nd Reason (*n* = 305)		3rd Reason (*n* = 245)	
	Freq.	%	Freq.	%	Freq.	%
I don't want to share with strangers	49	11.0%	54	17.7%	96	39.2%
It is quicker	167	37.5%	114	37.4%	12	4.9%
It is safer	167	37.5%	6	2.0%	4	1.6%
I don't want any delays during trip	22	4.9%	69	22.6%	90	36.7%
Privacy reasons	33	7.4%	57	18.7%	36	14.7%
Other	7	1.6%	5	1.6%	7	2.9%

Table 42. Reasons for using UberX instead of Taxi (Q9 UberX Users Only)

Responses	1st Reason (*n* = 445)		2nd Reason (*n* = 358)		3rd Reason (*n* = 303)	
	Freq.	%	Freq.	%	Freq.	%
It is cheaper	326	73.3%	8	2.2%	2	0.7%
Easier to use and pay in app	27	6.1%	117	32.7%	117	38.6%
It is quicker	42	9.4%	121	33.8%	17	5.6%
Enironmentally friendly	7	1.6%	43	12.0%	44	14.5%
Less wait time	5	1.1%	21	5.9%	94	31.0%
It is safer	36	8.1%	46	12.8%	23	7.6%
Other	2	0.4%	2	0.6%	6	2.0%

Table 43. Reasons for using Uberpool instead of UberX or Taxi (Q19 Uberpool Users Only)

Responses	1st Reason (*n* = 455)		2nd Reason (*n* = 394)		3rd Reason (*n* = 383)	
	Freq.	%	Freq.	%	Freq.	%
It is cheaper	421	92.5%	1	0.3%	2	0.5%
More environmentally friendly	3	0.7%	181	45.9%	86	22.5%
Want to help reduce traffic congestion	5	1.1%	17	4.3%	160	41.8%
Want to meet people during trip	1	0.2%	76	19.3%	89	23.2%
It is safer	14	3.1%	77	19.5%	27	7.0%
It is quicker	9	2.0%	41	10.4%	17	4.4%
Other	2	0.4%	1	0.3%	2	0.5%

Table 44. Reasons for using UberX or Uberpool instead of PT (Q10 UberX & Q11 Uberpool)

Responses	UberX		Uberpool		UberX vs. Uberpool
	Freq.	Percentage	Freq.	Percentage	*p*-value
1. It is cheaper	*n* = 417		*n* = 437		0.000
Strongly Disagree	42	10.1%	106	24.3%	
Disagree	150	36.0%	182	41.6%	
Undecided/Neutral	34	8.2%	35	8.0%	
Agree	71	17.0%	30	6.9%	
Strongly Agree	120	28.8%	84	19.2%	
2. It is quicker	*n* = 434		*n* = 447		0.000
Strongly Disagree	5	1.2%	4	0.9%	
Disagree	13	3.0%	8	1.8%	
Undecided/Neutral	22	5.1%	17	3.8%	
Agree	148	34.1%	103	23.0%	
Strongly Agree	246	56.7%	315	70.5%	
3. It is safer	*n* = 413		*n* = 450		0.000
Strongly Disagree	10	2.4%	2	0.4%	
Disagree	20	4.8%	7	1.6%	
Undecided/Neutral	91	22.0%	60	13.3%	
Agree	110	26.6%	166	36.9%	
Strongly Agree	182	44.1%	215	47.8%	
4. More comfortable to travel by car	*n* = 429		*n* = 450		0.047
Strongly Disagree	2	0.5%	2	0.4%	
Disagree	14	3.3%	9	2.0%	
Undecided/Neutral	43	10.0%	37	8.2%	
Agree	133	31.0%	125	27.8%	

Table 44. (continued)

Strongly Agree	237	55.2%	277	61.6%	
5. Door to Door Service	*n* = 429		*n* = 450		0.146
Strongly Disagree	6	1.4%	4	0.9%	
Disagree	10	2.3%	18	4.0%	
Undecided/Neutral	42	9.7%	45	10.0%	
Agree	131	30.3%	157	35.0%	
Strongly Agree	244	56.4%	225	50.1%	

Table 44 Reasons for using UberX or Uberpool instead of PT (Q10 UberX & Q11 Uberpool) (continued)

Responses	UberX		Uberpool		UberX vs. Uberpool
	Freq.	Percentage	Freq.	Percentage	*p*-value
6. Ease of requesting service and payment	*n* = 427		*n* = 447		0.017
Strongly Disagree	5	1.2%	2	0.4%	
Disagree	19	4.4%	14	3.1%	
Undecided/Neutral	40	9.4%	41	9.2%	
Agree	145	34.0%	122	27.3%	
Strongly Agree	218	51.1%	268	60.0%	
7. No public transport near origin/destination	*n* = 422		*n* = 432		0.011
Strongly Disagree	52	12.7%	92	21.3%	
Disagree	104	25.3%	137	31.7%	
Undecided/Neutral	106	25.8%	57	13.2%	
Agree	71	17.3%	56	13.0%	
Strongly Agree	78	19.0%	90	20.8%	

Table 45. How Often the Uber Service Used (Q11 Uber & Q12 Uberpool)

Responses	UberX (*n* = 447)		Uberpool (*n* = 454)	
	Frequency	Percentage	Frequency	Percentage
Twice or more daily	57	12.8%	39	8.6%
Once a day	28	6.3%	55	12.1%
2-4 times a week	120	26.8%	139	30.6%
Once or twice a week	82	18.3%	121	26.7%
Less than once a week	30	6.7%	33	7.3%
Once or twice a month	92	20.6%	37	8.1%
Less than once a month	12	2.7%	13	2.9%
Occasionally (i.e., 2-3 times a year)	20	4.5%	12	2.6%
Other	6	1.3%	5	1.1%
UberX vs. Uberpool	*χ2 (df): 46.72*		*P-Value: 0.000*	

Table 46. Frequency of use in the last month (Q12 UberX & Q13 Uberpool)

Service	Range	Median	Mean	*p*-value
UberX	0 - 100	6.00	8.65	0.457
Uberpool	0 - 50	8.00	9.07	

Table 47. If Uber services were not available, what other transport mode would you most likely use for the same trip Descriptive Analysis Results for Question (Q13 UberX & Q14 Uberpool)

Responses	UberX		Uberpool		UberX vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
1. Drive Car Alone	*n* = 429		*n* = 454		0.000
Never	51	11.9%	46	10.1%	
Unlikely	221	51.5%	319	70.3%	
Maybe/Neutral	23	5.4%	17	3.7%	
Likely	68	15.9%	29	6.4%	
Always	66	15.4%	43	9.5%	
2. Get a lift from family/friends	*n* = 430		*n* = 451		0.015
Never	101	23.5%	107	23.7%	
Unlikely	153	35.6%	201	44.6%	
Maybe/Neutral	65	15.1%	62	13.7%	
Likely	97	22.6%	71	15.7%	
Always	14	3.3%	10	2.2%	
3. Car Club	*n = 428*		*n* = 450		0.004
Never	84	19.6%	101	22.4%	
Unlikely	221	51.6%	271	60.2%	
Maybe/Neutral	86	20.1%	48	10.7%	
Likely	31	7.2%	25	5.6%	
Always	6	1.4%	5	1.1%	
4. Other ridesourcing	*n* = 418		*n* = 453		
Never	80	19.1%	17	3.8%	0.001
Unlikely	112	26.8%	16	3.5%	
Maybe/Neutral	134	32.1%	88	19.4%	
Likely	80	19.1%	268	59.2%	
Always	12	2.9%	64	14.1%	
5. Train/Tube/Tram	*n* = 433		*n* = 450		0.076
Never	29	6.7%	39	8.7%	
Unlikely	25	5.8%	14	3.1%	
Maybe/Neutral	85	19.6%	121	26.9%	
Likely	200	46.2%	201	44.7%	
Always	94	21.7%	75	16.7%	

Table 47. If Uber services were not available, what other transport mode would you most likely use for the same trip Descriptive Analysis Results for Question (Q13 UberX & Q14 Uberpool) (continued)

Responses	UberX		Uberpool		UberX vs. Uberpool
	Frequency	Percentage	Frequency	Percentage	*p*-value
6. Public Transport Bus	*n* = 433		*n* = 450		0.228
Never	53	12.2%	31	6.9%	
Unlikely	27	6.2%	15	3.3%	
Maybe/Neutral	93	21.5%	133	29.6%	
Likely	178	41.1%	207	46.0%	
Always	82	18.9%	64	14.2%	
7. Taxi	*n* = 426		*n* = 448		0.000
Never	105	24.6%	116	25.9%	
Unlikely	97	22.8%	152	33.9%	
Maybe/Neutral	78	18.3%	87	19.4%	
Likely	120	28.2%	76	17.0%	
Always	26	6.1%	17	3.8%	
8. Cycle	*n* = 423		*n* = 451		0.024
Never	92	21.7%	98	21.7%	
Unlikely	230	54.4%	273	60.5%	
Maybe/Neutral	44	10.4%	44	9.8%	
Likely	38	9.0%	28	6.2%	
Always	19	4.5%	8	1.8%	
9. Walk	*n* = 426		*n* = 446		0.000
Never	66	15.5%	75	16.8%	
Unlikely	192	45.1%	280	62.8%	
Maybe/Neutral	54	12.7%	44	9.9%	
Likely	74	17.4%	35	7.8%	
Always	40	9.4%	12	2.7%	
10. Not make this trip	*n* = 426		*n* = 426		0.278
Never	71	18.2%	29	6.5%	
Unlikely	248	63.6%	358	80.6%	
Maybe/Neutral	47	12.1%	33	7.4%	
Likely	20	5.1%	21	4.7%	
Always	4	1.0%	3	0.7%	

Table 48. Transport mode used MOST before Uber, for same journeys (Q14 UberX & Q15 Uberpool)

Responses	UberX (*n* = 444)		Uberpool (*n* = 454)	
	Frequency	Percentage	Frequency	Percentage
Use tube/train/tram	124	27.9%	139	30.6%
Use public transport bus	117	26.4%	134	29.5%
Use taxi	75	16.9%	75	16.5%
Drive car alone	66	14.9%	36	7.9%
Get a lift from a family/friend	29	6.5%	27	5.9%
Cycle	10	2.3%	14	3.1%
Walk	7	1.6%	14	3.1%
I did not make the same trips	4	0.9%	11	2.4%
Other	1	0.2%	2	0.4%
	χ2 (df)		*P*-Value	
	23.62		0.005	

Table 49. Would you still use Uber, if you had better access to PT options (Q15 UberX & Q16Uberpool)

Responses	UberX (*n* = 432)		Uberpool (*n* = 449)	
	Frequency	Percentage	Frequency	Percentage
Yes	279	64.6%	252	56.1%
Only for certain journeys	93	21.5%	137	30.5%
No	37	8.6%	32	7.1%
Only during bad weather	23	5.3%	28	6.2%
	χ2 (df)		*P*-Value	
	10.32		0.016	

Table 50. Rating of Service (Q16 UberX & Q17 Uberpool)

Responses	UberX (*n* = 444)		Uberpool (*n* = 453)	
	Frequency	Percentage	Frequency	Percentage
Very poor	36	8.1%	25	5.5%
Poor	6	1.4%	10	2.2%
Average	63	14.2%	181	40.0%
Good	152	34.2%	157	34.7%
Excellent	187	42.1%	80	17.7%

Table 51. Reasons for use of Uber instead of walking/cycling (Q17 UberX & Q18 Uberpool)

Responses	UberX		Uberpool		UberX vs. Uberpool
	Freq.	Percentage	Freq.	Percentage	*p*-value
1. It is quicker	*n* = 436		*n* = 454		0.740
Strongly Disagree	3	0.7%	0	0.0%	
Disagree	3	0.7%	7	1.5%	
Undecided/Neutral	9	2.1%	13	2.9%	
Agree	83	19.0%	74	16.3%	
Strongly Agree	338	77.5%	360	79.3%	
2. It is safer	*n* = 422		*n* = 451		0.000
Strongly Disagree	5	1.2%	2	0.4%	
Disagree	17	4.0%	6	1.3%	
Undecided/Neutral	47	11.1%	23	5.1%	
Agree	115	27.3%	121	26.8%	
Strongly Agree	238	56.4%	299	66.3%	
3. More comfortable to travel by car	*n* = 426		*n* = 450		0.004
Strongly Disagree	3	0.7%	0	0.0%	
Disagree	5	1.2%	4	0.9%	
Undecided/Neutral	54	12.7%	41	9.1%	
Agree	89	20.9%	77	17.1%	
Strongly Agree	275	64.6%	328	72.9%	
4. It is too far to walk or cycle	*n* = 421		*n* = 449		0.092
Strongly Disagree	6	1.4%	0	0.0%	
Disagree	21	5.0%	21	4.7%	
Undecided/Neutral	50	11.9%	47	10.5%	
Agree	96	22.8%	98	21.8%	
Strongly Agree	248	58.9%	283	63.0%	
5. Ease of requesting and paying for Uber	*n* = 416		*n* = 453		0.000
Strongly Disagree	9	2.2%	1	0.2%	
Disagree	18	4.3%	14	3.1%	
Undecided/Neutral	62	14.9%	42	9.3%	
Agree	103	24.8%	95	21.0%	
Strongly Agree	224	53.8%	301	66.4%	

Responses	UberX		Uberpool		UberX vs. Uberpool
	Freq.	Percentage	Freq.	Percentage	*p*-value
6. I don't have access to a bike	*n* = 396		*n* = 448		0.000
Strongly Disagree	24	6.1%	5	1.1%	
Disagree	54	13.6%	42	9.4%	
Undecided/Neutral	47	11.9%	46	10.3%	
Agree	77	19.4%	110	24.6%	
Strongly Agree	194	49.0%	245	54.7%	
7. I am unable to walk far or cycle	*n* = 384		*n* = 437		0.016
Strongly Disagree	76	19.8%	88	20.1%	
Disagree	108	28.1%	184	42.1%	
Undecided/Neutral	76	19.8%	57	13.0%	
Agree	57	14.8%	35	8.0%	
Strongly Agree	67	17.4%	73	16.7%	

Table 52. Hold a drivering license (Q18 UberX & Q20 Uberpool)

Responses	UberX (*n* = 446)		Uberpool (*n* = 449)	
	Frequency	Percentage	Frequency	Percentage
Yes	331	74.2%	326	72.6%
No	115	25.8%	123	27.4%
		χ2 (df)	P-value	
		0.297	0.586	

Table 53. Car owner at present (Q19 UberX & Q21 Uberpool)

Responses	UberX (*n* = 353)		Uberpool (*n* = 364)	
	Frequency	Percentage	Frequency	Percentage
Yes	170	48.2%	84	23.1%
No	183	51.8%	280	76.9%
		χ2 (df)	P-value	
		49.28	0.000	

Table 54. Car owner before starting to use Uber services (Q20 UberX & Q22 Uberpool)

Responses	UberX (*n* = 349)		Uberpool (*n* = 372)	
	Frequency	Percentage	Frequency	Percentage
Yes	191	42.4%	121	32.5%
No	158	35.1%	251	67.5%
		χ2 (df)		P-Value
		36.16		0.000

Table 55. Owner of Oyster/Travel Card for public transport (Q21 UberX & Q23 Uberpool)

Responses	UberX (*n* = 435)		Uberpool (*n* = 448)	
	Frequency	Percentage	Frequency	Percentage
Yes	389	89.4%	419	93.5%
No	46	10.6%	29	6.5%
	χ2 (df)		*P*-Value	
	4.78		0.029	

Table 56. Effect of UberX and Uberpool on car ownership (Q22 UberX & Q24 Uberpool)

Responses	UberX (*n* = 440)		Uberpool (*n* = 448)	
	Frequency	Percentage	Frequency	Percentage
No effect	79	18.0%	115	25.7%
Very little effect	58	13.2%	52	11.6%
Neutral	105	23.9%	109	24.3%
Some effect	121	27.5%	102	22.8%
Very high effect	77	17.5%	70	15.6%
			P-Value	
			0.016	

Table 57. Visitor or resident of London (Q23 UberX & Q25 Uberpool)

Responses	UberX (*n* = 440)		Uberpool (*n* = 440)	
	Frequency	Percentage	Frequency	Percentage
Yes	389	89.8%	419	90.5%
No	46	10.2%	29	9.5%
		χ2 (df)	*P*-Value	
		0.115	0.735	

Table 58. Employment status (Q24 UberX & Q26 Uberpool)

Responses	UberX (*n* = 436)		Uberpool (*n* = 451)	
	Frequency	Percentage	Frequency	Percentage
Employed/Self Employed	346	79.4%	349	77.4%
Student	69	15.8%	67	14.9%
Unemployed	16	3.7%	23	5.1%
Retired	5	1.1%	12	2.7%
		χ2 (df)	*P*-Value	
		3.93	0.269	

Table 59. Age group (Q25 UberX & Q27 Uberpool)

Responses	UberX (*n* = 447)		Uberpool (*n* = 453)	
	Frequency	Percentage	Frequency	Percentage
18-25	98	21.9%	71	15.7%
26-30	102	22.8%	92	20.3%
31-35	102	22.8%	71	15.7%
36-40	58	13.0%	77	17.0%
41-45	38	8.5%	47	10.4%
46-50	28	6.3%	54	11.9%
51-55	16	3.6%	26	5.7%
56 or over	5	1.1%	15	3.3%
	χ2 (df)		*P*-Value	
	29.60		0.000	

Table 60. Gender (Q26 UberX & Q28 Uberpool)

Responses	UberX (*n* = 448)		Uberpool (*n* = 453)	
	Frequency	Percentage	Frequency	Percentage
Female	223	49.8%	227	50.1%
Male	225	50.2%	226	49.9%
		χ2 (df)	*P*-Value	
		0.010	0.920	

Table 61. Highest level of education completed (Q27 UberX & Q29 Uberpool)

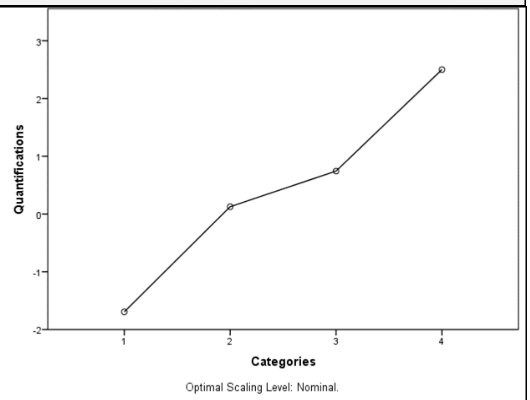
Responses	UberX (n = 444)		Uberpool (n = 456)	
	Frequency	Percentage	Frequency	Percentage
Primary school	3	0.7%	13	2.9%
Secondary school	22	5.0%	31	6.8%
Undergraduate/college	270	60.8%	280	61.4%
Postgraduate	141	31.8%	128	28.1%
None	8	1.8%	4	0.9%
		$\chi 2$ (df)	P-Value	
		12.08	0.034	

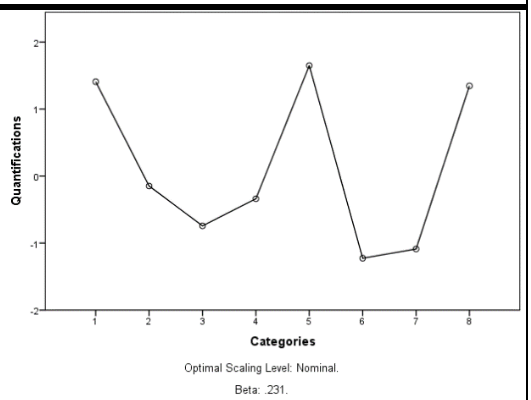
Appendix D: CATREG modelling quantification plots

There were four main CATREG models developed. The quantification plots for each model are provided in this section. These plots the findings detailed in chapter seven of this thesis. To interpret the CATREG quantification plots, the beta value is considered, and the plots are for each variable are examined to check the changes in quantifications for different categories of the factors (variables). When the beta value is positive, then the importance of information changes proportionally to the quantifications. In addition, when the beta value is found to be negative, that indicates the changes are related vice versa to the quantifications.

Factors that affect the frequency of using Uberpool services (CATREG model 1)

Figure 9: Quantification plots for Factors that affect the frequency of using Uberpool services (CATREG model 1)

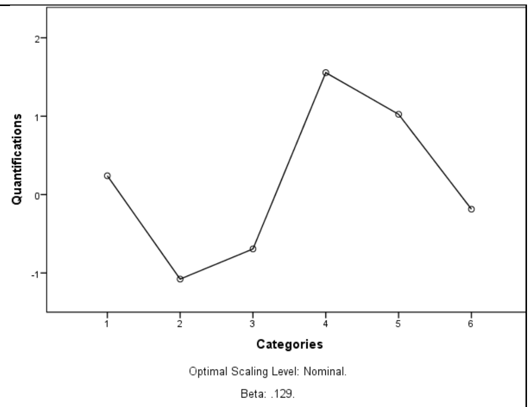
<table>
<tr><th>Variables</th><th>Categories & quantification values</th><th>Quantification Plot</th></tr>
<tr><td>The frequency of using Uberpool services - in general</td><td>
<table>
<tr><th>Categories</th><th>Quantification</th></tr>
<tr><td>At least Once Daily</td><td>-1.693</td></tr>
<tr><td>Regular weekly (min once weekly)</td><td>.127</td></tr>
<tr><td>At least once Monthly</td><td>.744</td></tr>
<tr><td>Rarely</td><td>2.501</td></tr>
</table>
</td><td>


</td></tr>
<tr><td>Age group</td><td>
<table>
<tr><th>Categories</th><th>Quantification</th></tr>
<tr><td>18 to 25</td><td>1.408</td></tr>
<tr><td>26 to 30</td><td>-.148</td></tr>
<tr><td>31 to 35</td><td>-.743</td></tr>
<tr><td>36 to 40</td><td>-.338</td></tr>
<tr><td>41 to 45</td><td>1.649</td></tr>
<tr><td>46 to 50</td><td>-1.226</td></tr>
<tr><td>51 to 55</td><td>-1.088</td></tr>
<tr><td>56 or over</td><td>1.345</td></tr>
</table>
</td><td>


</td></tr>
</table>

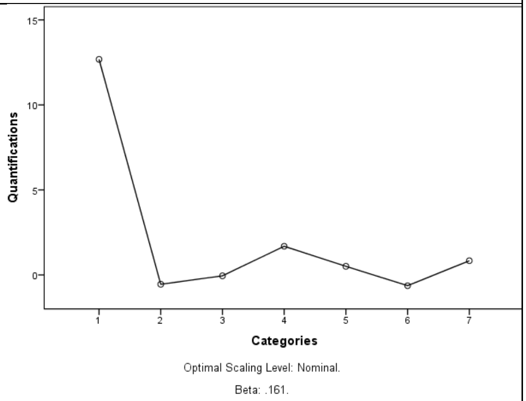
Trip Purpose

Categories	Quantification
Home	.240
Work or School/College/ Uni	-1.078
PT Station/Stop	-.693
Shopping/Family errands/Other	1.556
Social Event/Activity	1.024
Airport	-.187



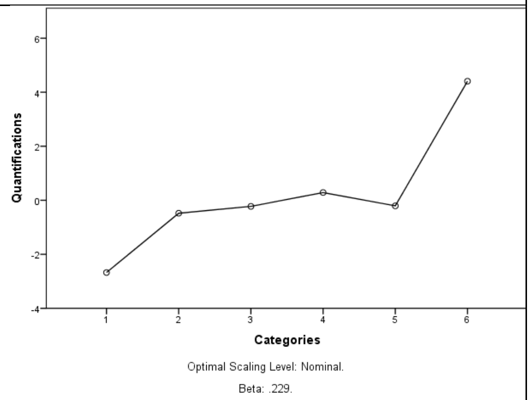
Trip Origin/Start

Categories	Quantification
Airport	12.680
At home	-.548
social event/activity	-.052
Family or friends place	1.687
Office/ workplace	.507
PT station /Stop	-.632
Other	.835



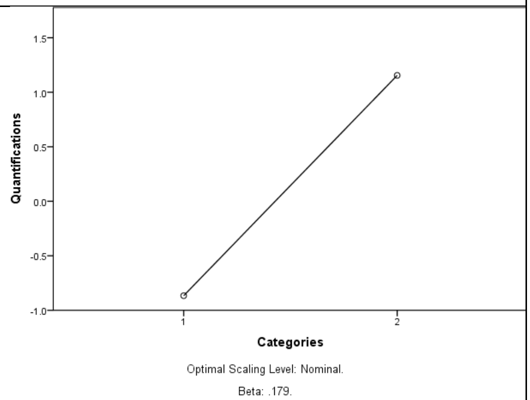
Average fare Saving Compared to UberX Service.

Categories	Quantification
Less than 4%	-2.674
5% to 10%	-.480
11% to 20%	-.225
21% to 30%	.285
More than 35%	-.206
I don't use UberX / I Don't know	4.408



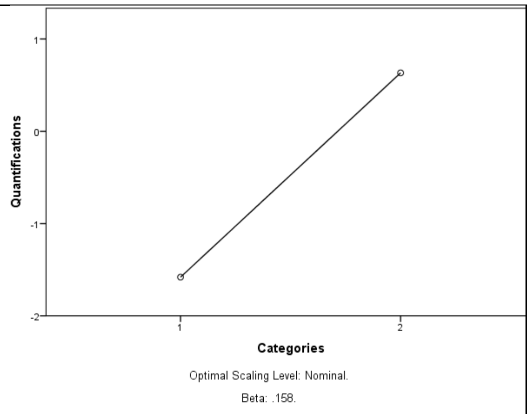
When trips are made _ Night

Categories	Quantification
Frequent	-.866
Infrequent	1.155



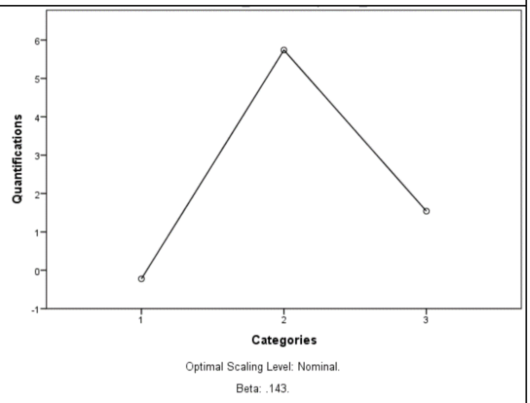
When trips are made _ Weekdays

Categories	Quantification
Frequent	-1.581
Infrequent	.632



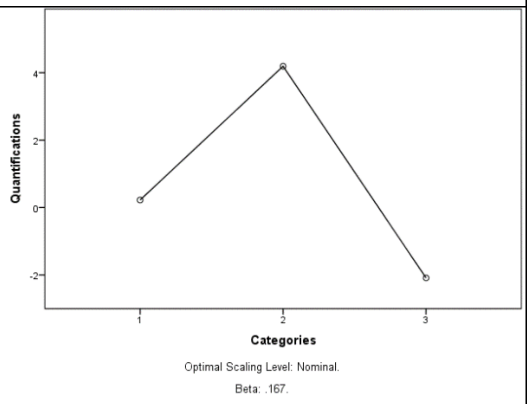
Perceived quickness of services compared to PT modes

Categories	Quantification
Agree	-.223
Disagree	5.740
Neutral /Undecided	1.541



Perceived safety compared to PT modes

Categories	Quantification
Agree	.223
Disagree	4.192
Neutral /Undecided	-2.088



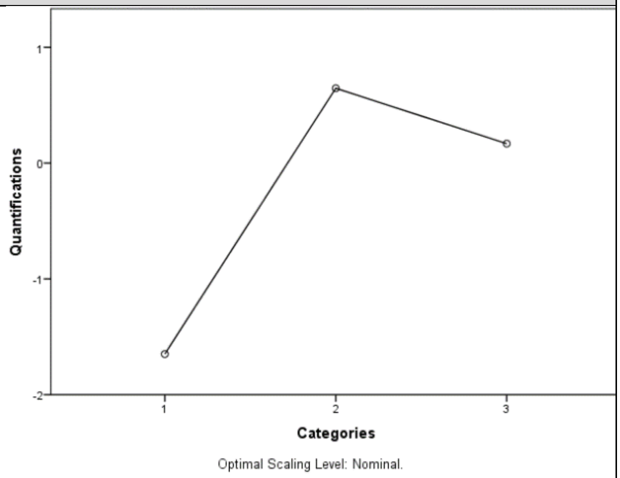
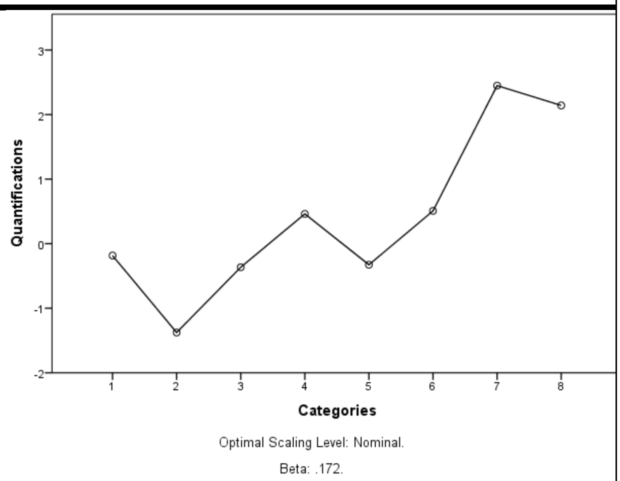
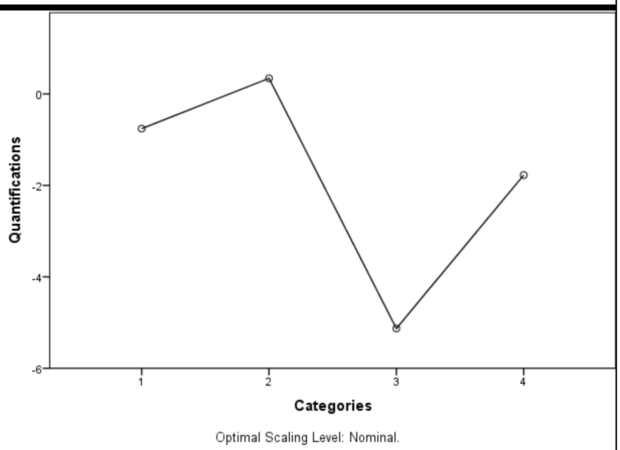
The factors that affect passengers' decision to use Uberpool instead (CATREG Model 2)

This CATREG model had 3 sub-models because the dependent variable had three different categories as follows and the quantification plots are provided for each model in the figures below.

- CATREG model 2A – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, '*because it is cheaper*'
- CATREG model 2B – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, '*because it is a door-to-door Service*'

- CATREG model 2C – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, *'because there is no PT stop/station near my origin/destination'*

Figure 10: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of public transport modes 'because it is Cheaper'(CATREG model 2A).

<table>
<tr><th>Variable</th><th>Categories & quantification values</th><th>Quantification Plots</th></tr>
<tr><td>Reason for using Uberpool instead of public transport modes ' because it is Cheaper'</td><td><table><tr><th>Categories</th><th>Quantification</th></tr><tr><td>Agree</td><td>-1.649</td></tr><tr><td>Disagree</td><td>.646</td></tr><tr><td>Neutral /Undecided</td><td>.168</td></tr></table></td><td>
</td></tr>
<tr><td>Age Group</td><td><table><tr><th>Categories</th><th>Quantification</th></tr><tr><td>18 to 25</td><td>-.184</td></tr><tr><td>26 to 30</td><td>-1.377</td></tr><tr><td>31 to 35</td><td>-.365</td></tr><tr><td>36 to 40</td><td>.461</td></tr><tr><td>41 to 45</td><td>-.326</td></tr><tr><td>46 to 50</td><td>.508</td></tr><tr><td>51 to 55</td><td>2.449</td></tr><tr><td>56 or over</td><td>2.141</td></tr></table></td><td>
</td></tr>
<tr><td>Employment status</td><td><table><tr><th>Categories</th><th>Quantification</th></tr><tr><td>I am a student</td><td>-.759</td></tr><tr><td>I am Employed / Self Employed</td><td>.341</td></tr><tr><td>I am Retired</td><td>-5.130</td></tr><tr><td>I am Unemployed</td><td>-1.774</td></tr></table></td><td>
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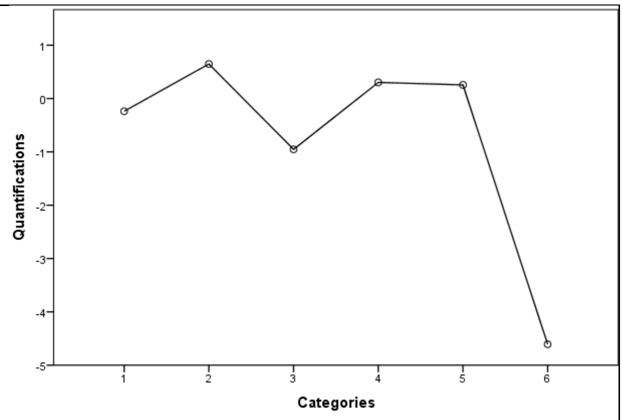
Trip Purpose

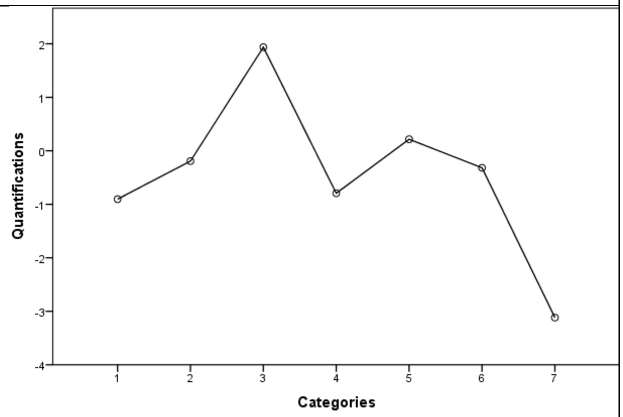
Categories	Quantification
Home	-.239
Work or School/College /Uni	.648
PT Station/Stop	-.953
Shopping/Family errands/visiting/ Other	.303
Social Event/Activity	.255
Airport	-4.609



Optimal Scaling Level: Nominal.
Beta: .107.

Trip Origin/Start

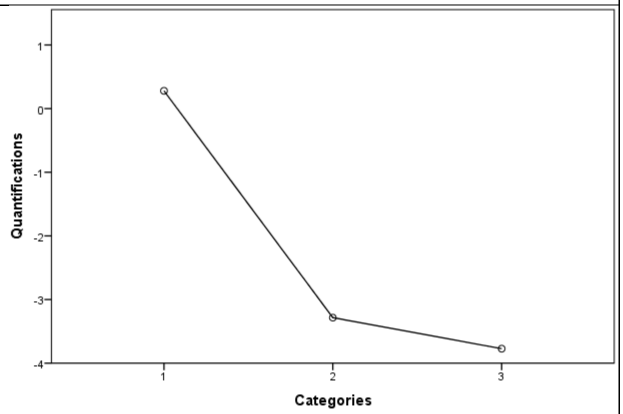
Categories	Quantification
Airport	-.904
At home	-.193
At social event/activity (i.e., gym, bar)	1.937
Family or friends place	-.793
Office/workplace	.216
Public Transport station	-.318
Other	-3.117



Optimal Scaling Level: Nominal.
Beta: .155.

Perceived quickness of services compared to PT modes

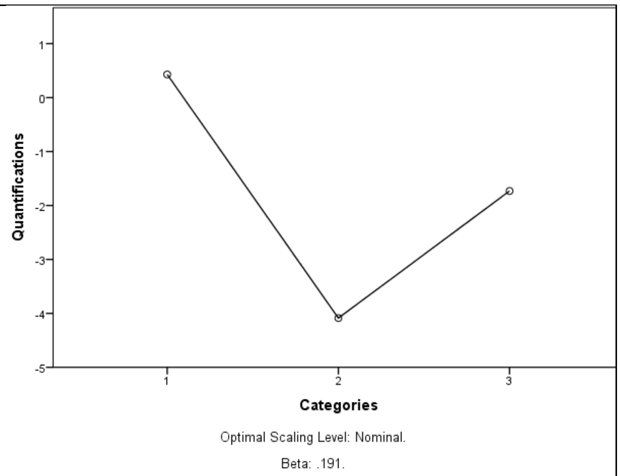
Categories	Quantification
Agree	.279
Disagree	-3.285
Neutral/ Undecided	-3.772



Optimal Scaling Level: Nominal.
Beta: .154.

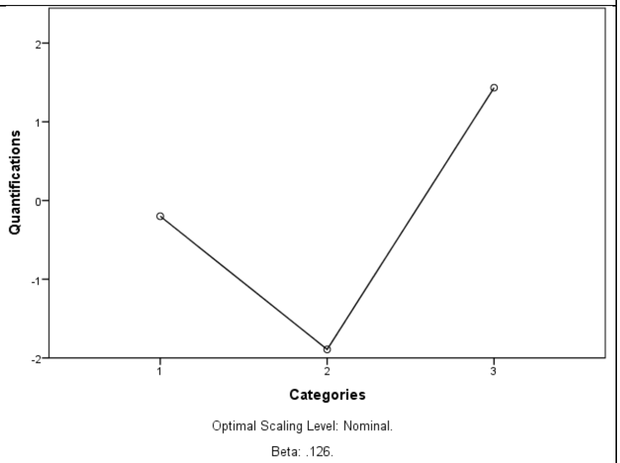
Perceived safety compared to PT modes

Categories	Quantification
Agree	.429
Disagree	-4.088
Neutral/ Undecided	-1.731



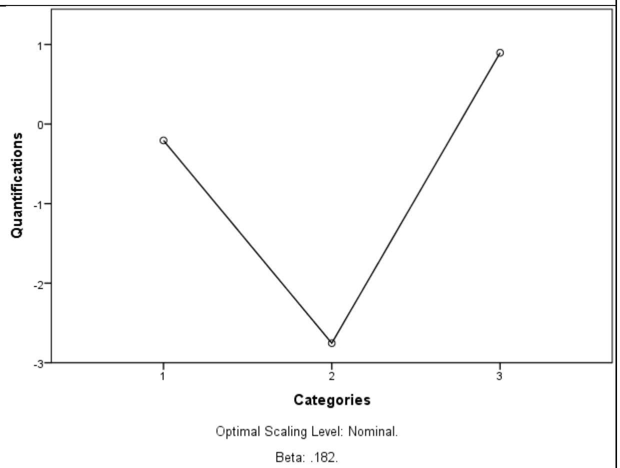
Any objection to divert during trip to pickup/drop-off others

Categories	Quantification
Agree	-.200
Disagree	-1.892
Neutral /Undecided	1.433



Uberpool Service Rating

Categories	Quantification
Excellent	-.206
Poor	-2.755
Average	.896



Car ownership at present

Categories	Quantification
Yes	-1.864
No	.537

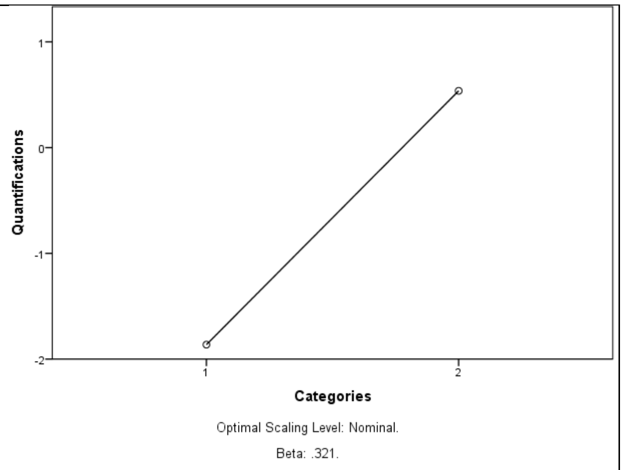
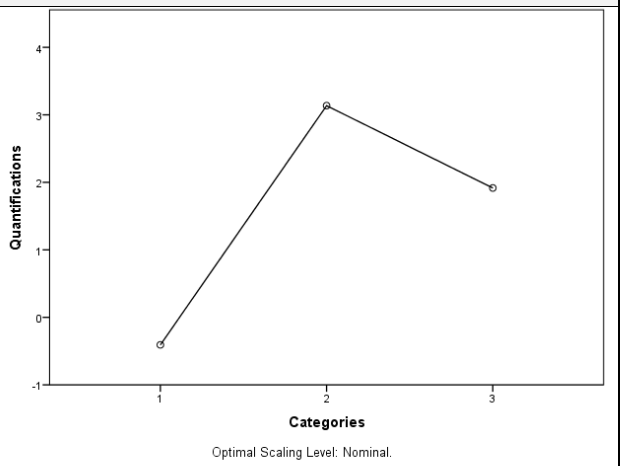


Figure 11: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of Public Transport modes, 'because it is a door-to-door Service' (CATREG model 2B)

Variable	Categories & quantification values	Quantification Plots

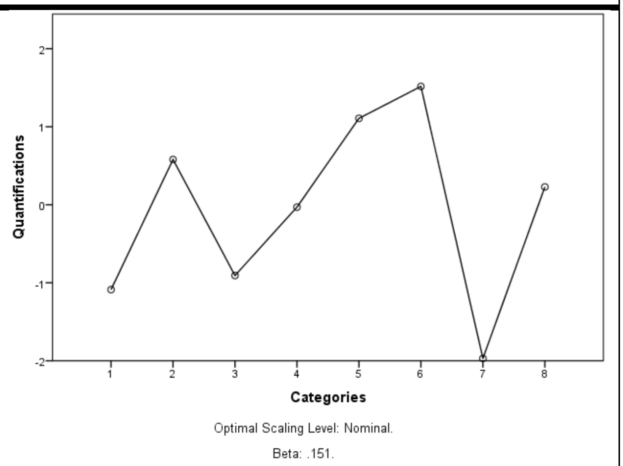
The factors that affect passengers' decision to use Uberpool instead of public transport modes, because it is a door-to-door service

Categories	Quantification
Agree	-.408
Disagree	3.136
Neutral/ Undecided	1.916



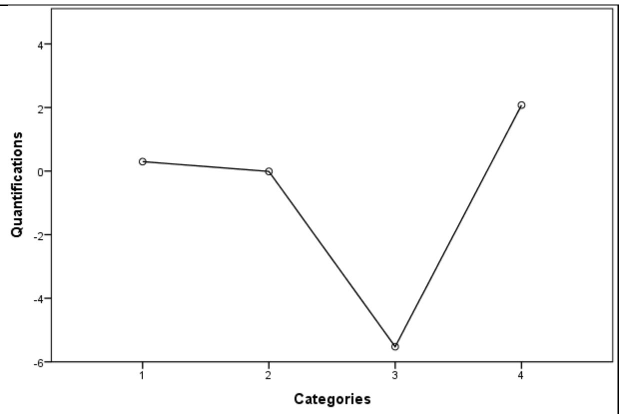
Age group

Categories	Quantification
18 to 25	-1.088
26 to 30	.580
31 to 35	-.907
36 to 40	-.031
41 to 45	1.107
46 to 50	1.516
51 to 55	-1.970
56 or over	.228



Employment status

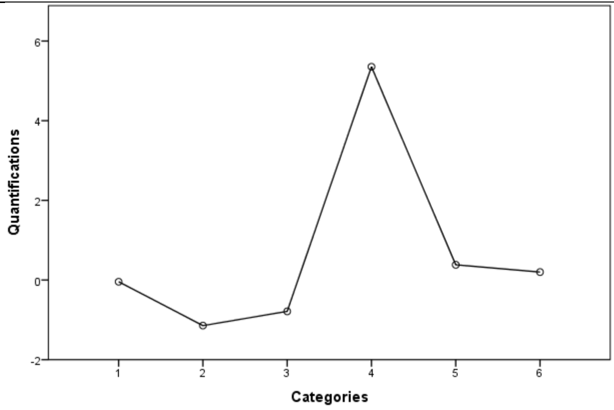
Categories	Quantification
I am a student	.297
I am Employed / Self Employed	-.011
I am Retired	-5.523
I am Unemployed	2.076



Optimal Scaling Level: Nominal.
Beta: .095.

Highest Education Level completed

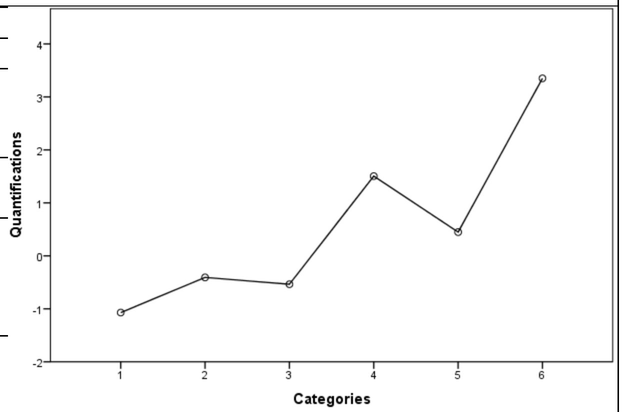
Categories	Quantification
College	-.043
None	-1.145
Post-graduate	-.788
Primary School	5.354
Secondary School	.382
Under-graduate	.199



Optimal Scaling Level: Nominal.
Beta: .120.

Trip Purpose

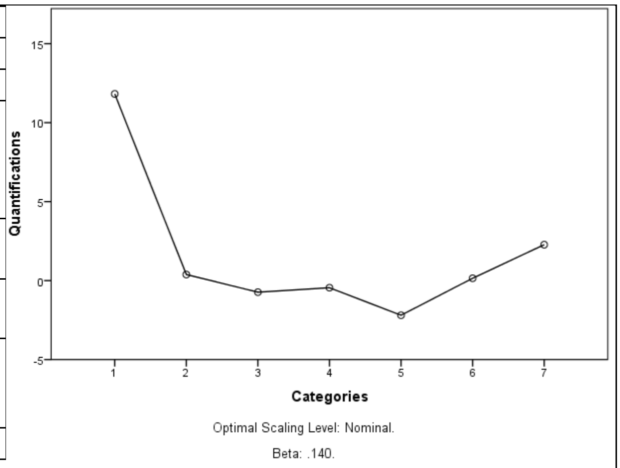
Categories	Quantification
Home	-1.071
Work or School/College/Uni	-.407
PT Station /Stop	-.536
Shopping/ Family errands/ other	1.505
Social Event/ Activity	.448
Airport	3.351



Optimal Scaling Level: Nominal.
Beta: .159.

Trip Origin/Start

Categories	Quantification
Airport	11.819
At home	.384
At social event/ activity (i.e., gym, bar)	-.732
Family or friends place	-.450
Office/ workplace	-2.192
Public Transport station	.148
Other	2.272



Perceived safety compared to PT modes

Categories	Quantification
Agree	-.420
Disagree	1.099
Neutral/ Undecided	2.475

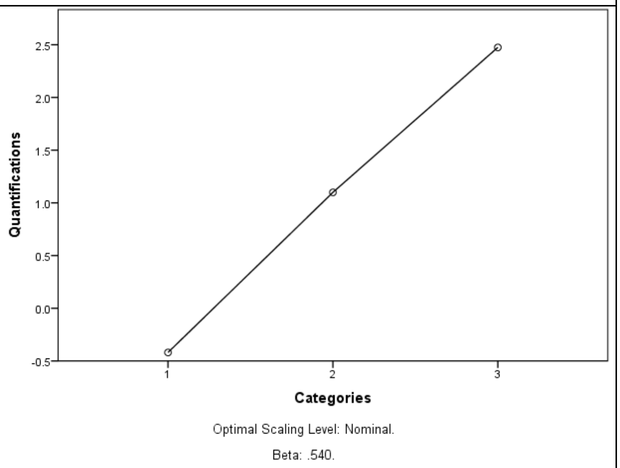
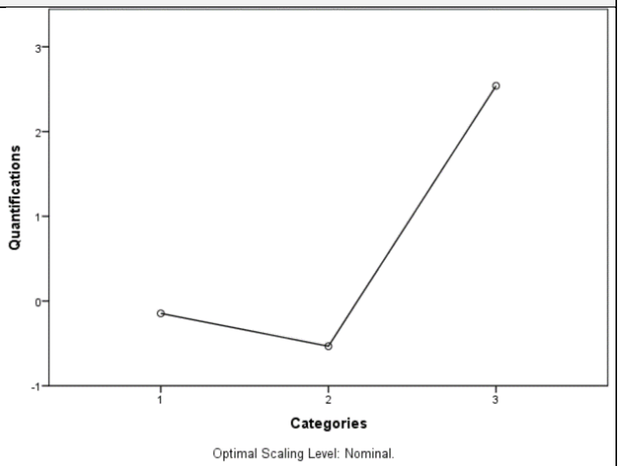


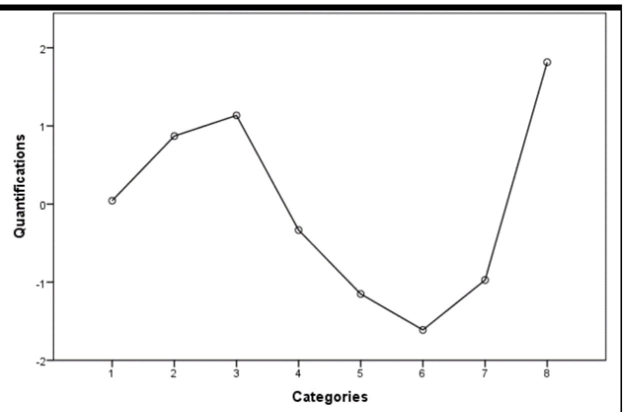
Figure 12: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of public transport modes, 'because there is no PT stop/station near origin/destination (CATREG model 2C)

Variable	Categories & quantification values	Quantification Plots
Reason for using Uberpool instead of public transport modes ' because there is no PT stop/station near origin/destination	see table below	

Categories	Quantification
Agree	-.146
Disagree	-.533
Neutral/ Undecided	2.539

Age group

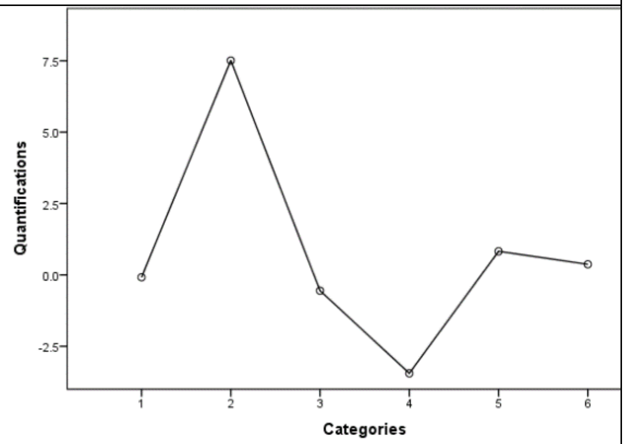
Categories	Quantification
18 to 25	.043
26 to 30	.870
31 to 35	1.134
36 to 40	-.333
41 to 45	-1.152
46 to 50	-1.612
51 to 55	-.973
56 or over	1.816



Optimal Scaling Level: Nominal.
Beta: .138.

Highest Education Level completed

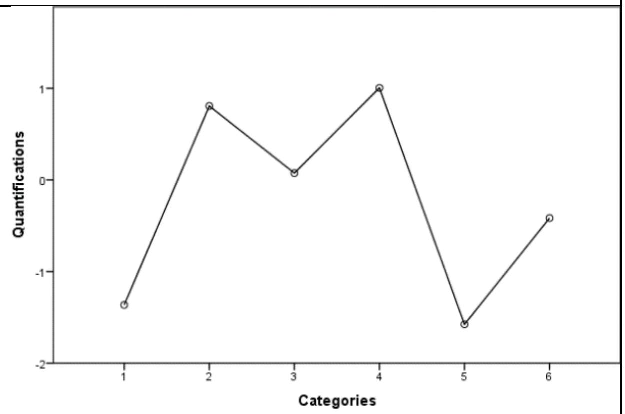
Categories	Quantification
College	-.082
None	7.508
Post-graduate	-.552
Primary School	-3.444
Secondary School	.826
Under-graduate	.371



Optimal Scaling Level: Nominal.
Beta: .124.

Trip Purpose

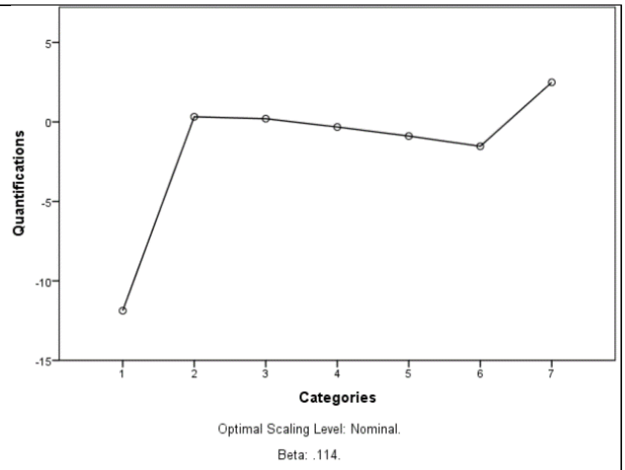
Categories	Quantification
Home	-1.364
Work or School/College/ Uni	.807
PT Station/ Stop	.074
Shopping/ Family errands/ Other	1.005
Social Event/ Activity	-1.576
Airport	-.416



Optimal Scaling Level: Nominal.
Beta: .204.

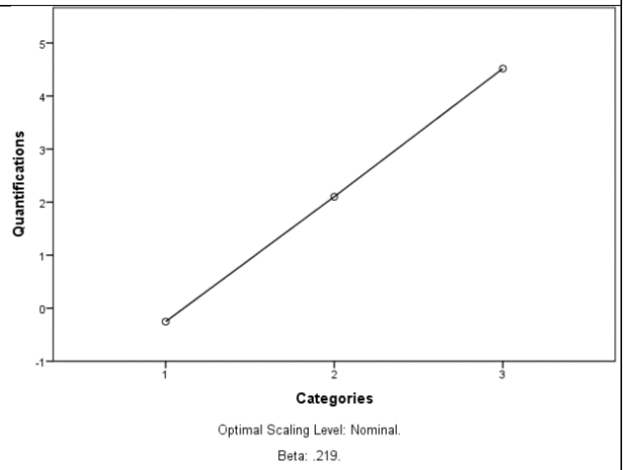
Trip Origin/Start

Categories	Quantification
Airport	-11.879
At home	.322
At social event/activity (i.e., gym)	.202
Family or friends place	-.320
Office/workplace	-.890
PT Stop/ station	-1.530
Other	2.489



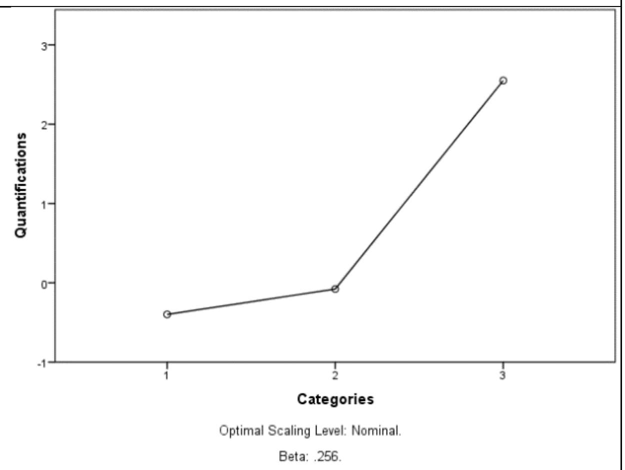
Perceived quickness of services compared to PT modes (Q11B)

Categories	Quantification
Agree	-.254
Disagree	2.101
Neutral/ Undecided	4.518



Perceived safety compared to PT modes

Categories	Quantification
Agree	-.399
Disagree	-.079
Neutral/ Undecided	2.550

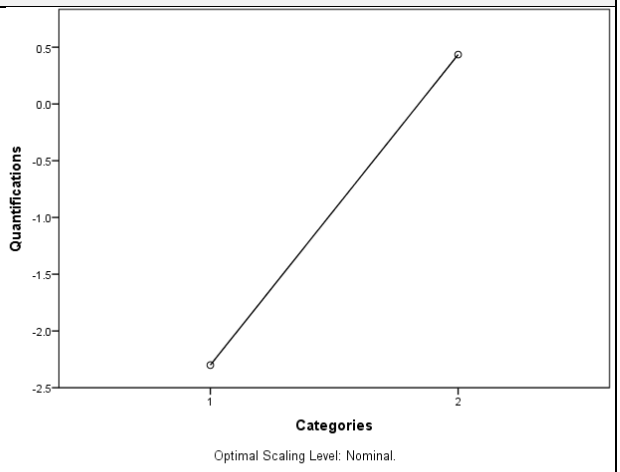


The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi (CATREG Model 3)

This CATREG model has five (5) sub-models because the dependent variable has six different response options, however option A (because it is cheaper) was excluded from this model since it did not have enough data variation. The five sub-models are as follows and the quantification plots are provided below.

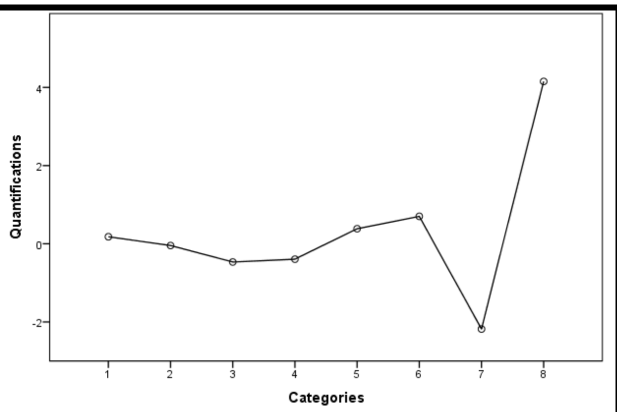
- CATREG model 3A – The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is quicker'
- CATREG model 3B – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, 'because I want to meet people during trip'
- CATREG model 3C – The factors that affect passengers' decision to use Uberpool instead of Public Transport modes, 'because it is safer'
- CATREG model 3D – The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is more environmentally friendly'
- CATREG model 3E – The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because I want to help reduce traffic congestion'

Figure 13: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is quicker' (CATREG model 3A)

<table>
<tr><th>Variable</th><th>Categories & quantification values</th><th>Quantification Plots</th></tr>
<tr><td>The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi because it is quicker</td><td><table><tr><th>Categories</th><th>Quantification</th></tr><tr><td>Yes</td><td>-2.301</td></tr><tr><td>No</td><td>.435</td></tr></table></td><td>
</td></tr>
</table>

Age group

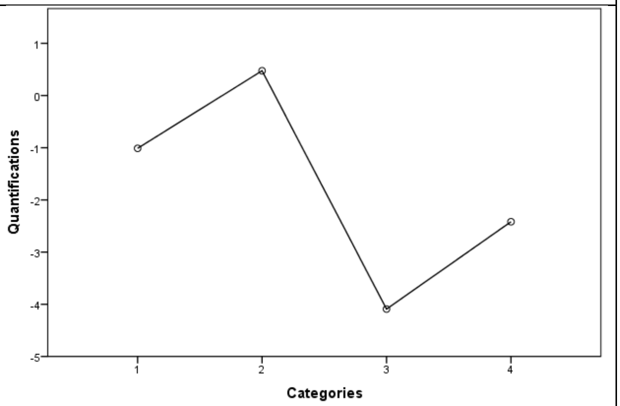
Categories	Quantification
18 to 25	.180
26 to 30	-.046
31 to 35	-.466
36 to 40	-.393
41 to 45	.385
46 to 50	.701
51 to 55	-2.181
56 or over	4.152



Optimal Scaling Level: Nominal.
Beta: .096.

Employment status

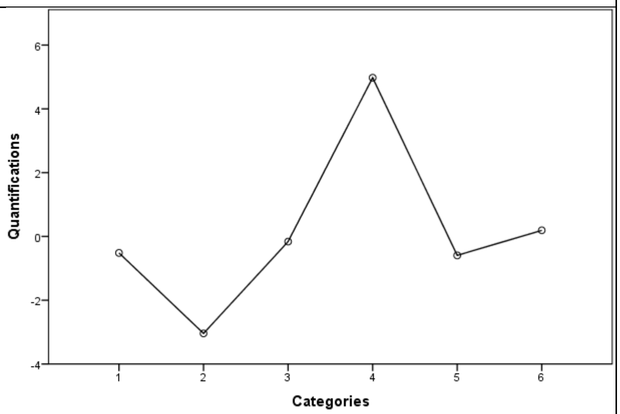
Categories	Quantification
I am a student	-1.011
I am Employed / Self Employed	.475
I am Retired	-4.091
I am Unemployed	-2.419



Optimal Scaling Level: Nominal.
Beta: .145.

Highest Education Level completed

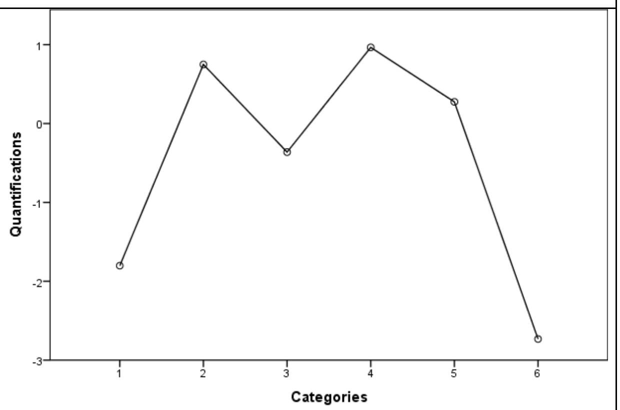
Categories	Quantification
College	-.517
None	-3.041
Post-graduate	-.162
Primary School	4.976
Secondary School	-.595
Under-graduate	.191



Optimal Scaling Level: Nominal.
Beta: .157.

Trip Purpose

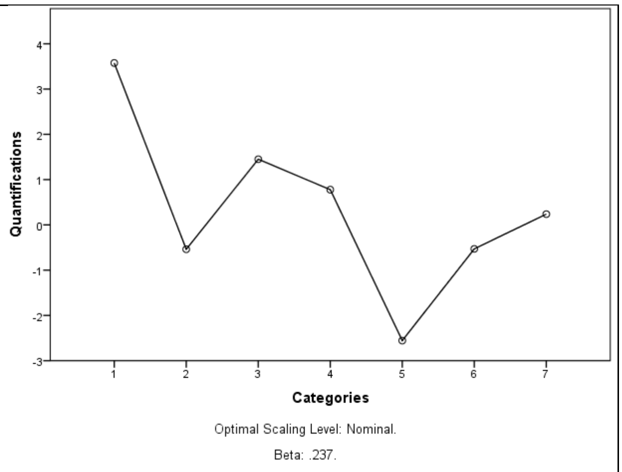
Categories	Quantification
Home	-1.803
Work or School/College/ Uni	.748
PT Stop/ Station	-.362
Shopping/ Family errands/ Other	.966
Social Event/ Activity	.274
Airport	-2.732



Optimal Scaling Level: Nominal.
Beta: .163.

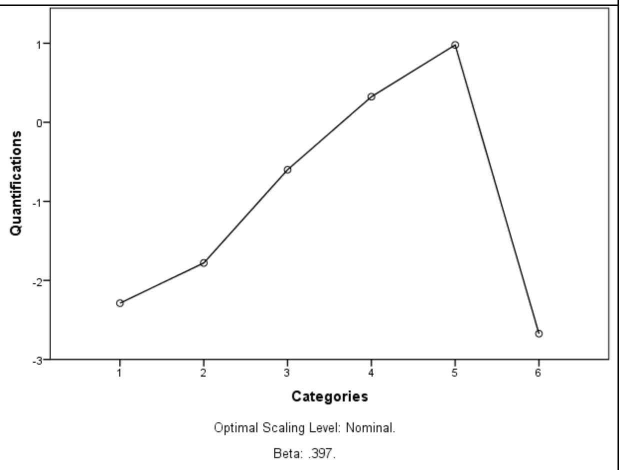
Trip Origin/Start

Categories	Quantification
Airport	3.576
At home	-.539
At social event/ activity	1.450
Family or friends place	.778
Office/ workplace	-2.556
PT stop/ Station	-.530
Other	.237



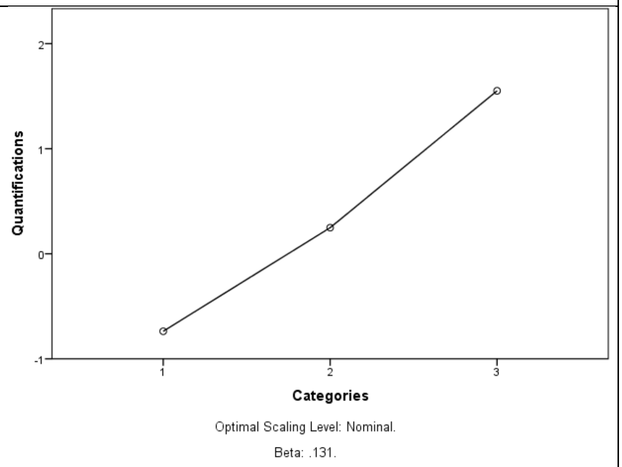
Average fare Saving Compared to UberX

Categories	Quantification
Less than 4%	-2.288
5% to 10%	-1.780
11% to 20%	-.600
21% to 30%	.323
More than 35%	.979
I don't use UberX / I Don't know	-2.674



Any objection to divert during trip to pickup/drop-off others

Categories	Quantification
Agree	-.738
Disagree	.248
Neutral/ Undecided	1.551



Uberpool Service Rating

Categories	Quantification
Excellent	-.771
Poor	-1.559
Average	1.104

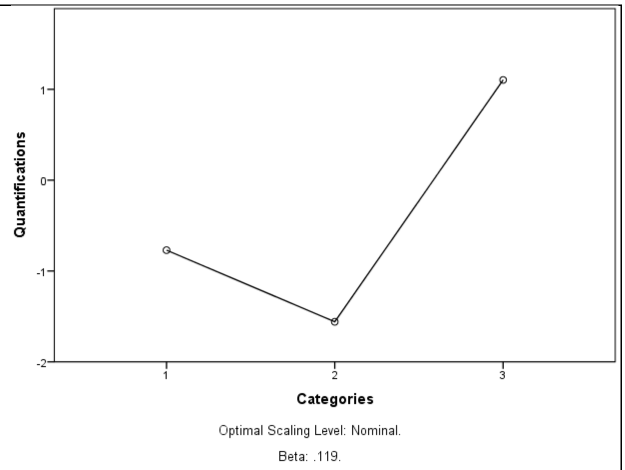
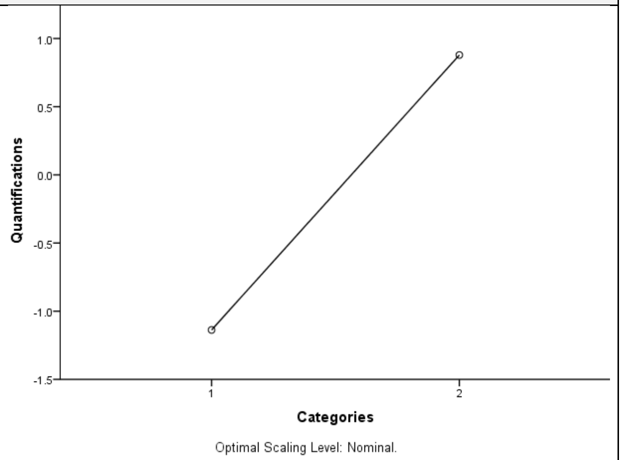


Figure 14: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because I want to meet people during trip' (CATREG model 3B)

Variable	Categories & quantification values	Quantification Plots

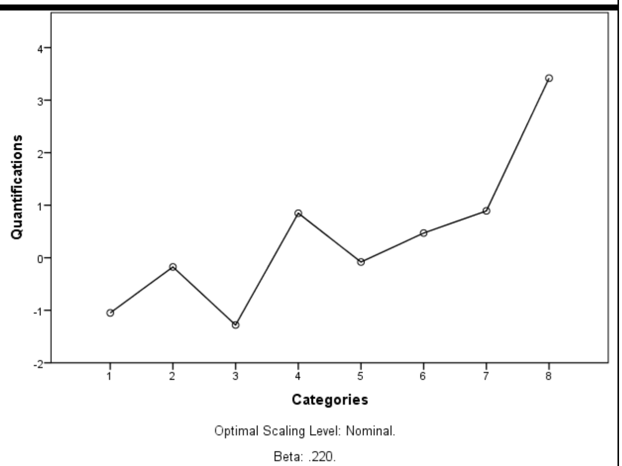
The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi because I want to meet people during trip

Categories	Quantification
Yes	-1.137
No	.879



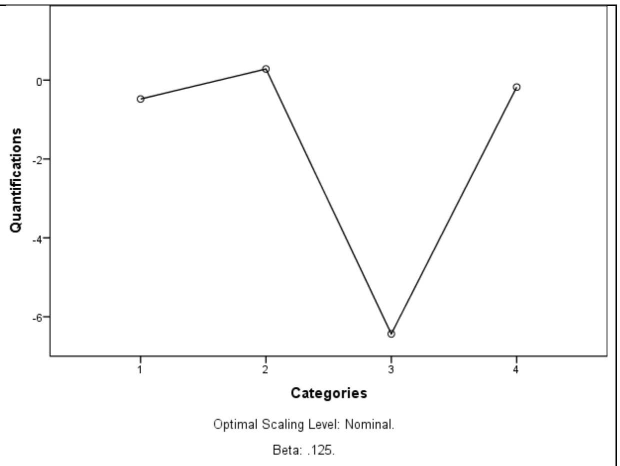
Age group

Categories	Quantification
18 to 25	-1.050
26 to 30	-.175
31 to 35	-1.281
36 to 40	.848
41 to 45	-.081
46 to 50	.470
51 to 55	.892
56 or over	3.417



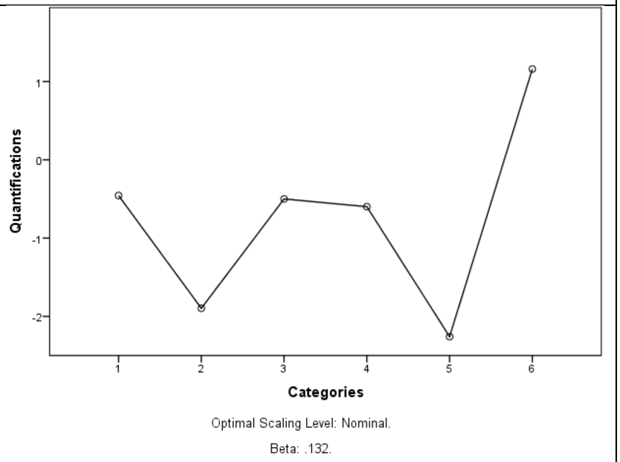
Employment status

Categories	Quantification
I am a student	-.479
I am Employed / Self Employed	.282
I am Retired	-6.435
I am Unemployed	-.177



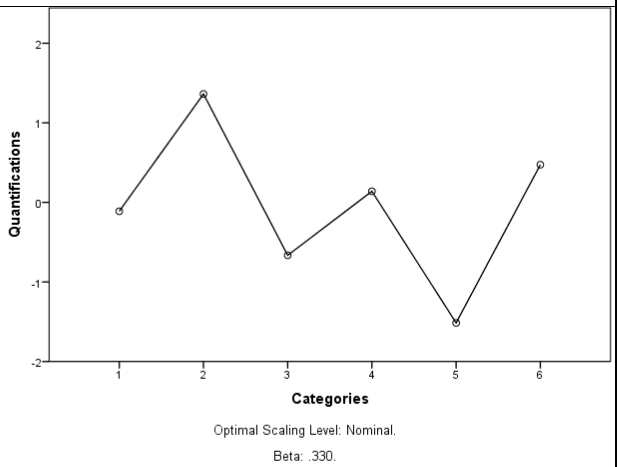
Highest Education Level completed

Categories	Quantification
College	-.456
None	-1.897
Post-graduate	-.499
Primary School	-.599
Secondary School	-2.259
Under-graduate	1.159



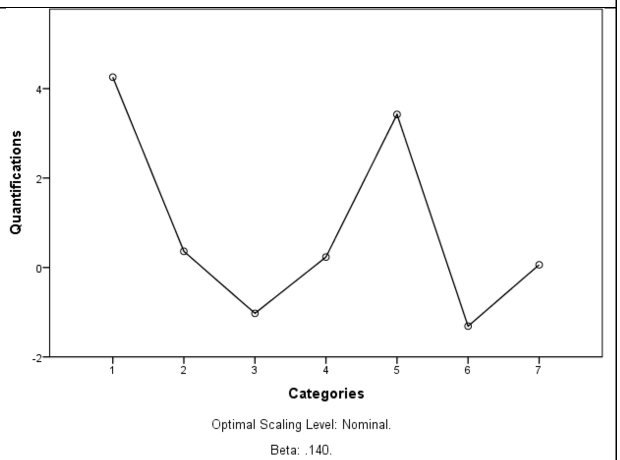
Trip Purpose

Categories	Quantification
Home	-.112
Work or School/College/Uni	1.362
PT Stop/ Station	-.665
Shopping/ Family errands/ Other	.139
Social Event/ Activity	-1.515
Airport	.473



Trip Origin/Start

Categories	Quantification
Airport	4.257
At home	.361
At social event/ activity	-1.025
Family or friends place	.234
Office/ workplace	3.422
PT station/Stop	-1.312
Other	.060



Average fare Saving Compared to UberX

Categories	Quantification
Less than 4%	.155
5% to 10%	-.084
11% to 20%	2.237
21% to 30%	-.491
More than 35%	-.343
I don't use UberX / I Don't know	-1.479

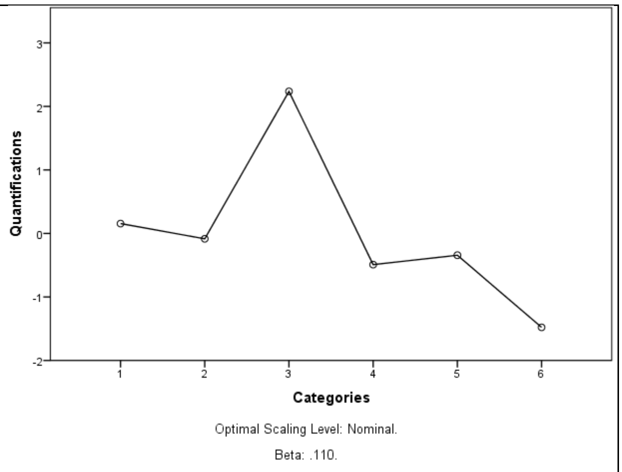
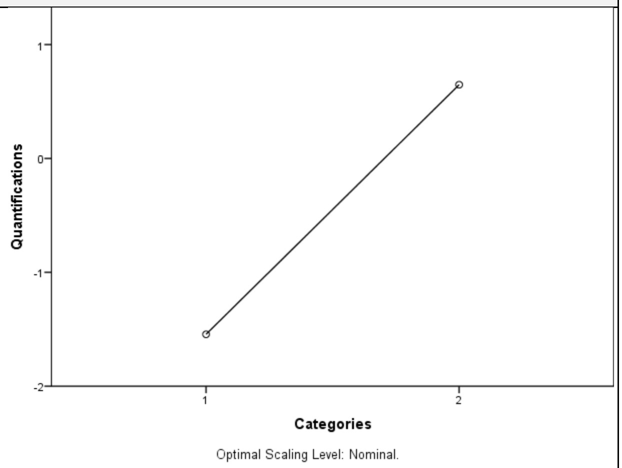


Figure 15: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is safer' (CATREG model 3C)

Variable	Categories & quantification values	Quantification Plots

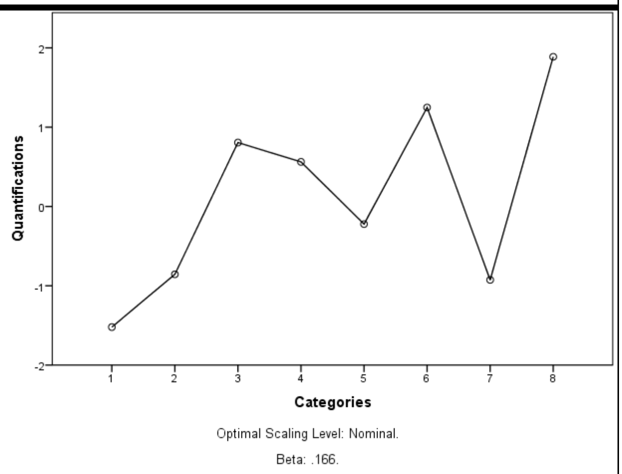
The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi because it is safer

Categories	Quantification
Yes	-1.544
No	.647



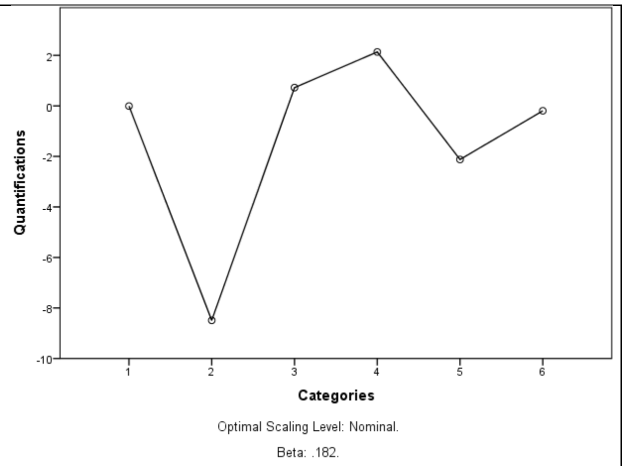
Age group

Categories	Quantification
18 to 25	-1.521
26 to 30	-.855
31 to 35	.806
36 to 40	.562
41 to 45	-.222
46 to 50	1.248
51 to 55	-.926
56 or over	1.887



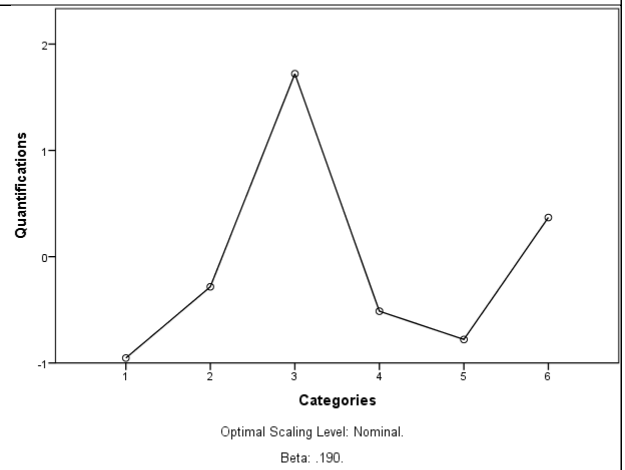
Highest Education Level completed

Categories	Quantification
College	-.008
None	-8.490
Post-graduate	.722
Primary School	2.135
Secondary School	-2.123
Under-graduate	-.195



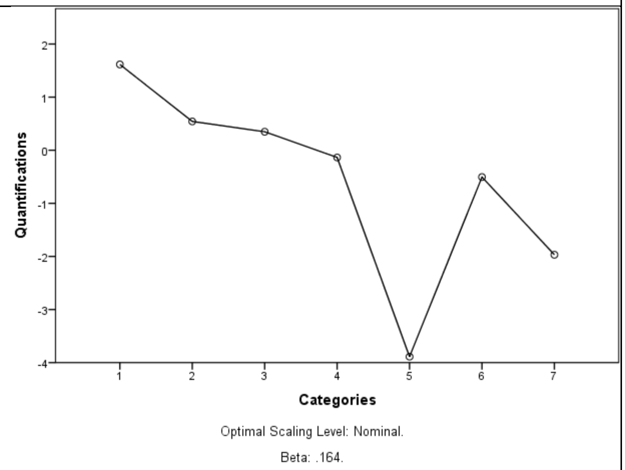
Trip Purpose

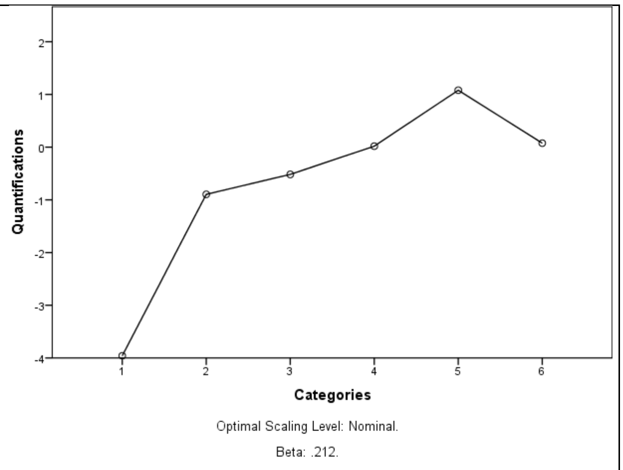
Categories	Quantification
Home	-.953
Work or School/ College/Uni	-.283
PT Stop/ Station	1.721
Shopping/Family errands/ Other	-.513
Social Event/ Activity	-.779
Airport	.369

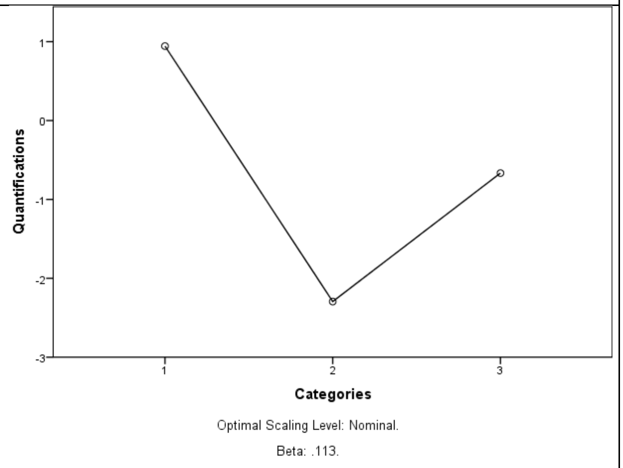


Trip Origin/Start

Categories	Quantification
Airport	1.616
At home	.542
At social event/ activity (i.e., gym, bar)	.348
Family or friends place	-.136
Office/work place	-3.889
PT Stop/ Station	-.505
Other	-1.969

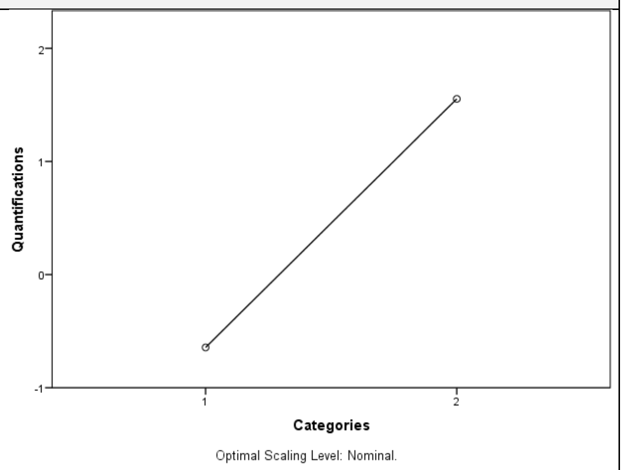


<table>
<tr><td>Average fare Saving Compared to UberX</td><td>
<table>
<tr><th>Categories</th><th>Quantification</th></tr>
<tr><td>Less than 4%</td><td>-3.959</td></tr>
<tr><td>5% to 10%</td><td>-.895</td></tr>
<tr><td>11% to 20%</td><td>-.517</td></tr>
<tr><td>21% to 30%</td><td>.019</td></tr>
<tr><td>More than 35%</td><td>1.080</td></tr>
<tr><td>I don't use UberX / I Don't know</td><td>.076</td></tr>
</table>
</td><td>


</td></tr>
<tr><td>Uberpool Service Rating</td><td>
<table>
<tr><th>Categories</th><th>Quantification</th></tr>
<tr><td>Excellent</td><td>.944</td></tr>
<tr><td>Poor</td><td>-2.295</td></tr>
<tr><td>Average</td><td>-.666</td></tr>
</table>
</td><td>


</td></tr>
</table>

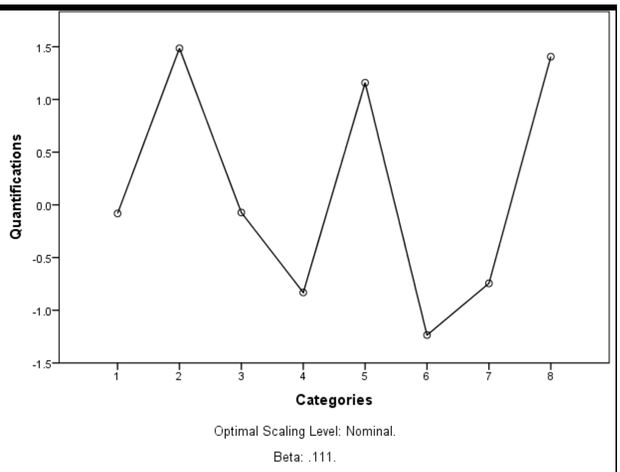
Figure 16: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because it is more environmentally friendly (CATREG model 3D)

<table>
<tr><th>Variable</th><th>Categories & quantification values</th><th>Quantification Plots</th></tr>
<tr><td>The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi because it is more environmentally friendly</td><td>
<table>
<tr><th>Categori es</th><th>Quantification</th></tr>
<tr><td>Yes</td><td>-.644</td></tr>
<tr><td>No</td><td>1.553</td></tr>
</table>
</td><td>


</td></tr>
</table>

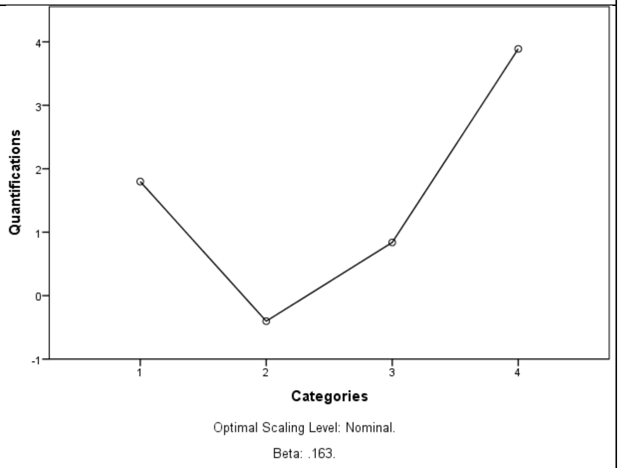
Age group

Categories	Quantification
18 to 25	-.081
26 to 30	1.485
31 to 35	-.073
36 to 40	-.832
41 to 45	1.158
46 to 50	-1.235
51 to 55	-.745
56 or over	1.406



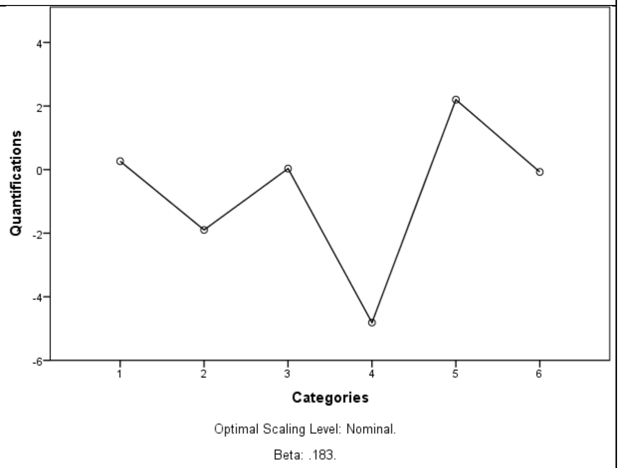
Employment status

Categories	Quantification
I am a student	1.798
I am Employed / Self Employed	-.402
I am Retired	.839
I am Unemployed	3.889



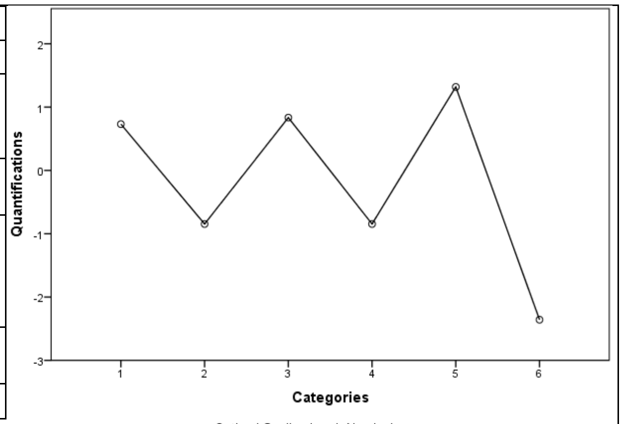
Highest Education Level completed

Categories	Quantification
College	.264
None	-1.897
Post-graduate	.033
Primary School	-4.812
Secondary School	2.200
Under-graduate	-.073



Trip Purpose

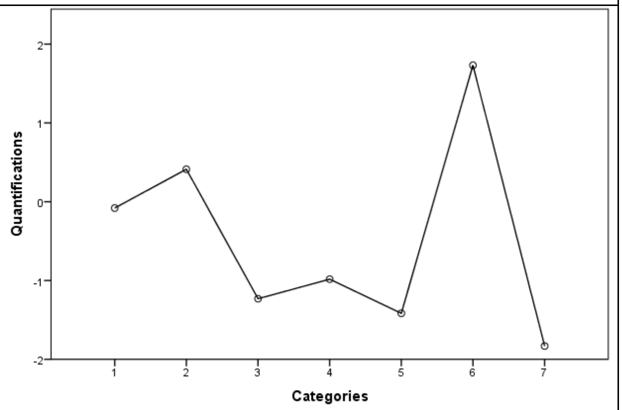
Categories	Quantification
Home	.731
Work or School/ College/Uni	-.846
PT Stop/ Station	.834
Shopping/ Family errands/ Other	-.846
Social Event/ Activity	1.318
Airport	-2.358



Optimal Scaling Level: Nominal.
Beta: .278.

Trip Origin/Start

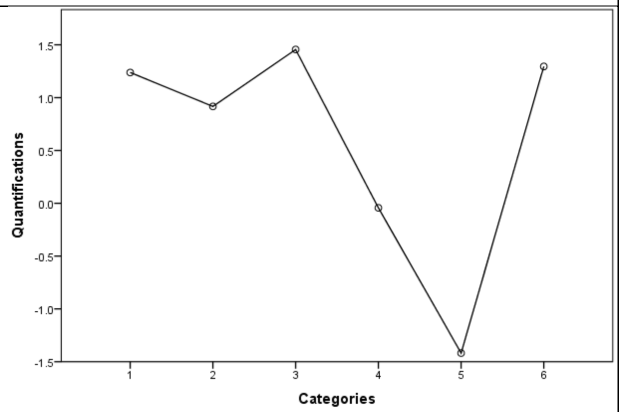
Categories	Quantification
Airport	-.080
At home	.412
At social event/ activity	-1.231
Family or friends place	-.983
Office/work place	-1.416
PT Stop/ station	1.731
Other	-1.831



Optimal Scaling Level: Nominal.
Beta: .194.

Average fare Saving Compared to UberX

Categories	Quantification
Less than 4%	1.238
5% to 10%	.917
11% to 20%	1.455
21% to 30%	-.043
More than 35%	-1.418
I don't use UberX / I Don't know	1.295



Optimal Scaling Level: Nominal.
Beta: .159.

Car ownership at present

Categories	Quantification
Yes	2.000
No	-.500

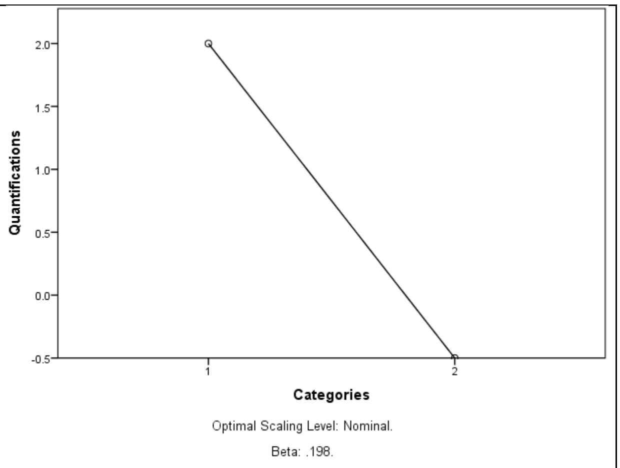
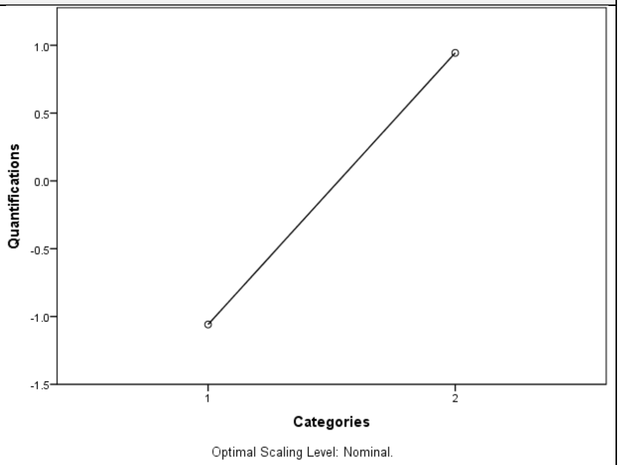


Figure 17: Quantification plots for the factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi 'because the user wants to help reduce traffic' (CATREG model 3E)

Variable	Categories & quantification values	Quantification Plots

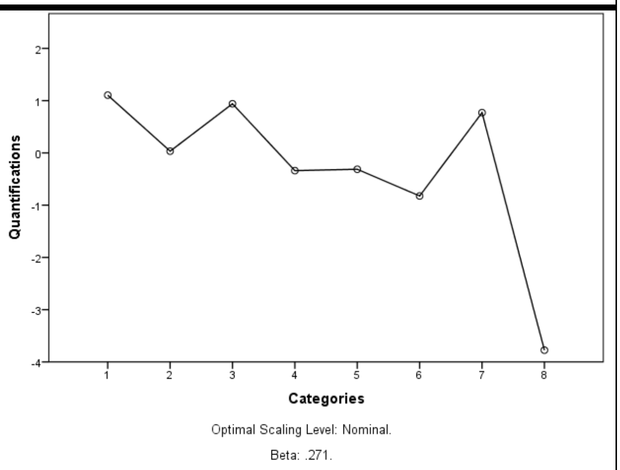
The factors that affect passengers' decision to use Uberpool instead of UberX or Traditional Taxi because the user wants to help reduce traffic

Categories	Quantification
Yes	-1.059
No	.944



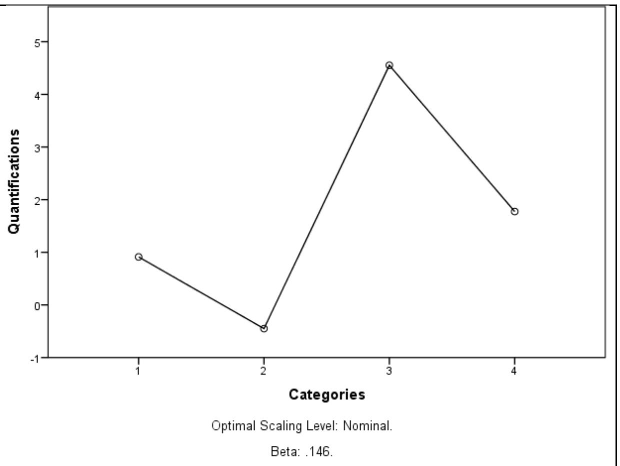
Age group

Categories	Quantification
18 to 25	1.105
26 to 30	.033
31 to 35	.941
36 to 40	-.340
41 to 45	-.313
46 to 50	-.825
51 to 55	.771
56 or over	-3.775



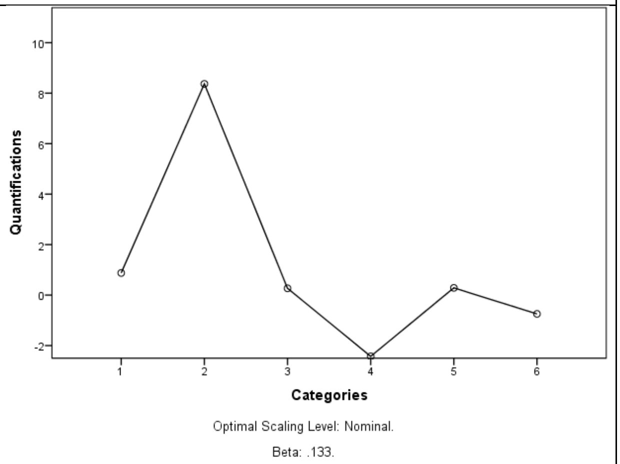
Employment status

Categories	Quantification
I am a student	.911
I am Employed / Self Employed	-.449
I am Retired	4.553
I am Unemployed	1.775



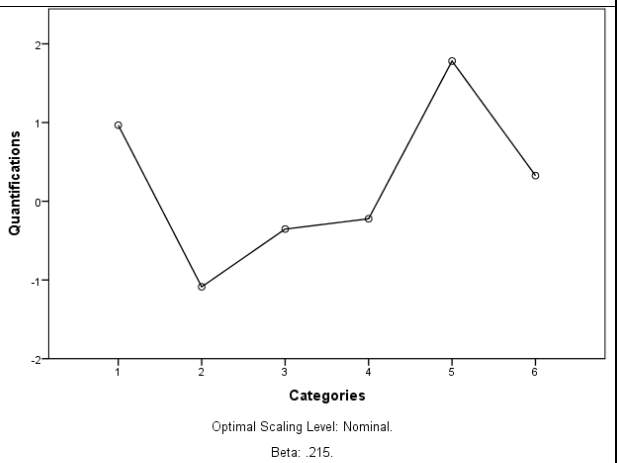
Highest Education Level completed

Categories	Quantification
College	.878
None	8.368
Post-graduate	.269
Primary School	-2.426
Secondary School	.287
Under-graduate	-.746



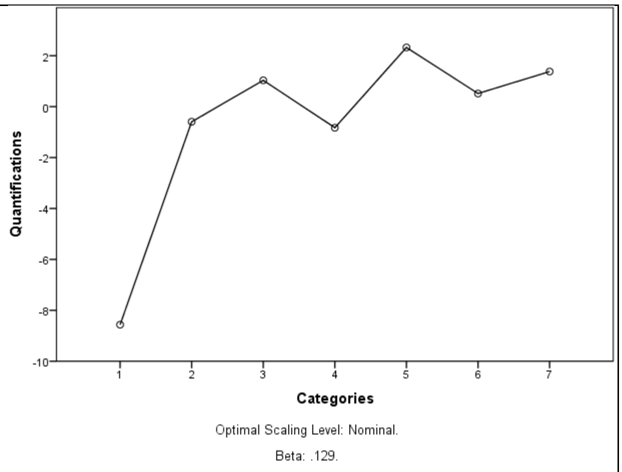
Trip Purpose

Categories	Quantification
Home	.967
Work or School/ College/Uni	-1.087
PT Station/ Stop	-.353
Shopping/ Family errands/ Other	-.223
Social Event/ Activity	1.782
Airport	.326



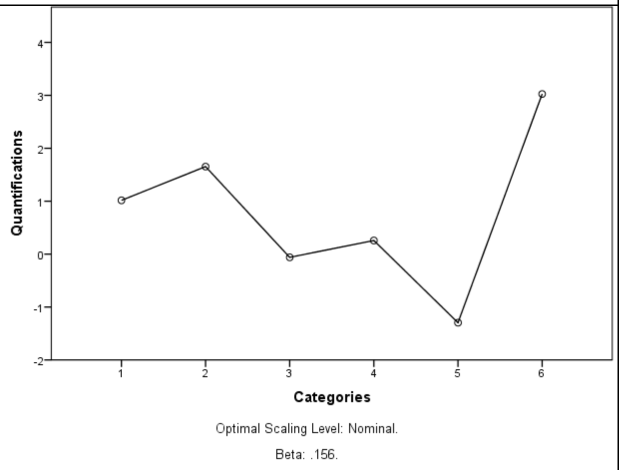
Trip Origin/Start

Categories	Quantification
Airport	-8.564
At home	-.594
At social event/activity (i.e., gym)	1.034
Family or friends place	-.829
Office/work place	2.325
PT Stop/ station	.515
Other	1.379



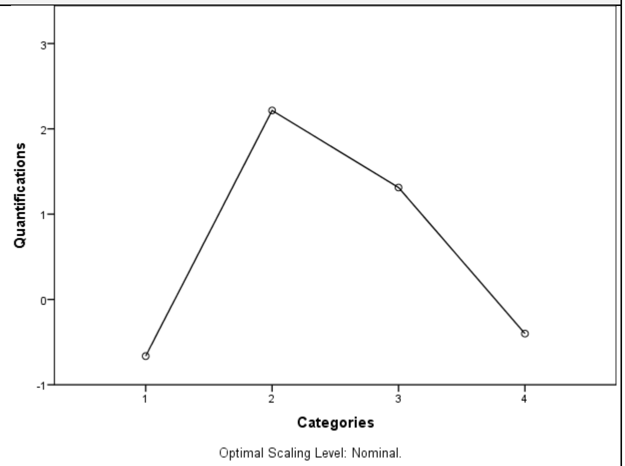
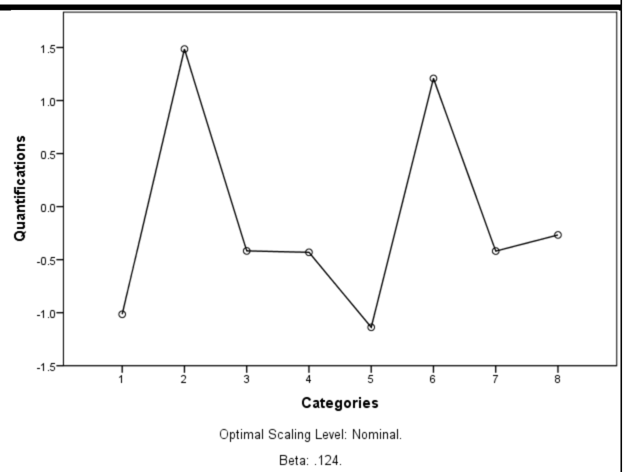
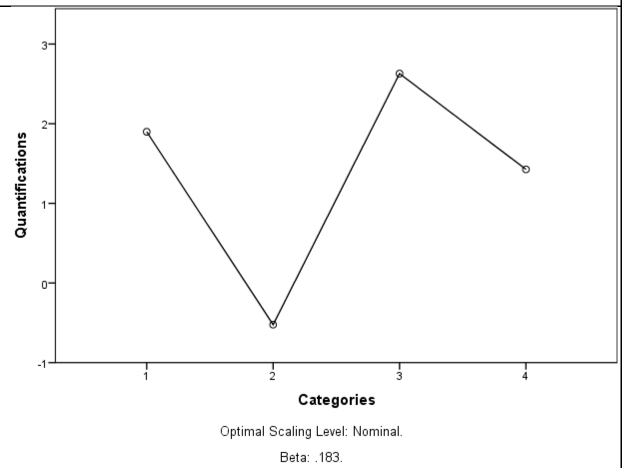
Average fare Saving Compared to UberX

Categories	Quantification
Less than 4%	1.016
5% to 10%	1.654
11% to 20%	-.061
21% to 30%	.258
More than 35%	-1.295
I don't use UberX / I Don't know	3.026



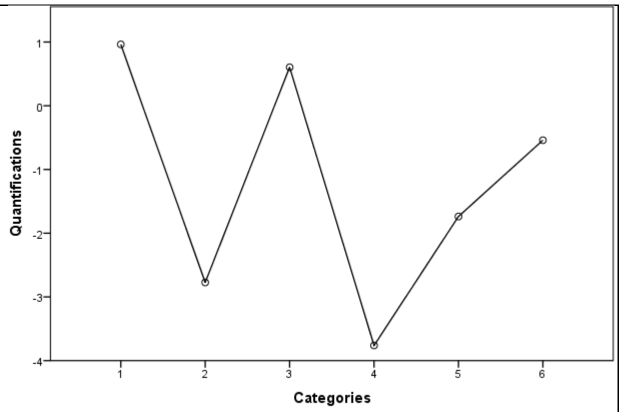
The transport modes that Uberpool services are replacing services (CATREG model 4)

Figure 18: Quantification plots for the factors that affect the transport modes which Uberpool services are replacing (CATREG model 4)

<table>
<tr><th>Variable</th><th>Categories & quantification values</th><th>Quantification Plots</th></tr>
<tr><td>The factors that affect the transport modes which Uberpool services are replacing</td><td>
<table>
<tr><th>Categories</th><th>Quantification</th></tr>
<tr><td>Use PT</td><td>-.664</td></tr>
<tr><td>Use Active Travel options</td><td>2.215</td></tr>
<tr><td>Use Car as Passenger</td><td>1.312</td></tr>
<tr><td>Drive Car alone</td><td>-.401</td></tr>
</table>
</td><td>
</td></tr>
<tr><td>Age group</td><td>
<table>
<tr><th>Categories</th><th>Quantification</th></tr>
<tr><td>18 to 25</td><td>-1.015</td></tr>
<tr><td>26 to 30</td><td>1.485</td></tr>
<tr><td>31 to 35</td><td>-.418</td></tr>
<tr><td>36 to 40</td><td>-.431</td></tr>
<tr><td>41 to 45</td><td>-1.138</td></tr>
<tr><td>46 to 50</td><td>1.208</td></tr>
<tr><td>51 to 55</td><td>-.419</td></tr>
<tr><td>56 or over</td><td>-.267</td></tr>
</table>
</td><td>
</td></tr>
<tr><td>Employment status</td><td>
<table>
<tr><th>Categories</th><th>Quantification</th></tr>
<tr><td>I am a student</td><td>1.899</td></tr>
<tr><td>I am Employed / Self Employed</td><td>-.524</td></tr>
<tr><td>I am Retired</td><td>2.629</td></tr>
<tr><td>I am Unemployed</td><td>1.426</td></tr>
</table>
</td><td>
</td></tr>
</table>

Highest Education Level completed

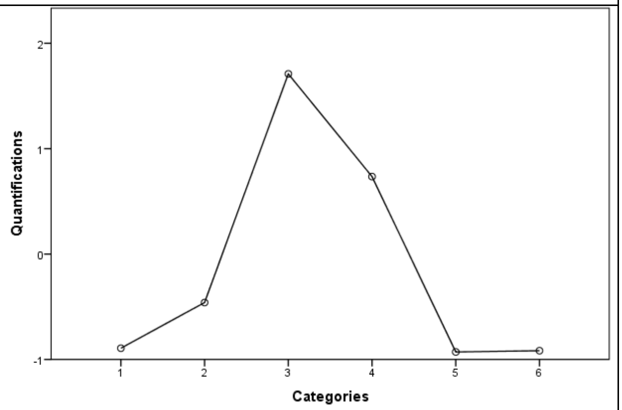
Categories	Quantification
College	.963
None	-2.773
Post-graduate	.604
Primary School	-3.762
Secondary School	-1.738
Under-graduate	-.540



Optimal Scaling Level: Nominal.
Beta: .069.

Trip Purpose

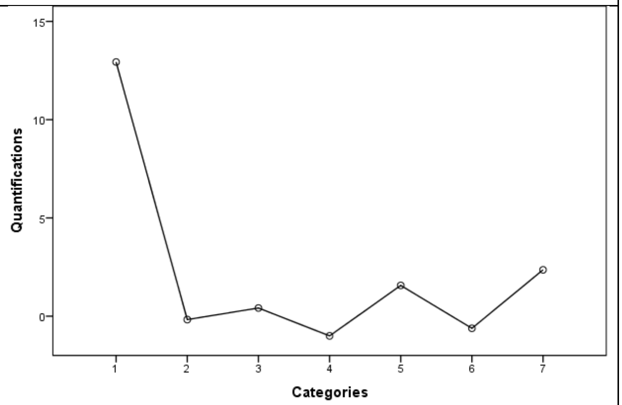
Categories	Quantification
Home	-.893
Work or School/ College/Uni	-.460
PT Station/ Stop	1.710
Shopping/Family errands/ visiting/ Other	.735
Social Event/ Activity	-.929
Airport	-.917



Optimal Scaling Level: Nominal.
Beta: .407.

Trip Origin/Start

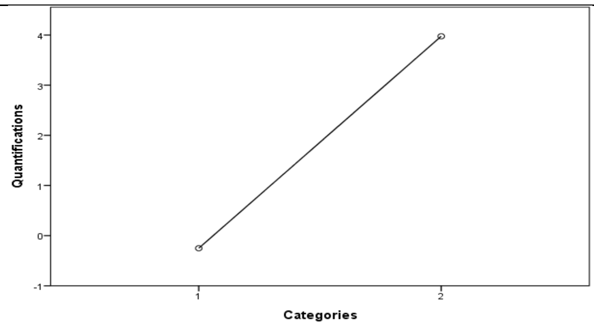
Categories	Quantification
Airport	12.934
At home	-.173
At social event/activity (i.e., gym, bar etc.)	.417
Family or friends place	-1.002
Office/ workplace	1.567
PT Stop/ station	-.617
Other	2.358



Optimal Scaling Level: Nominal.
Beta: .142.

Owner of Oyster Card (Travel card for PT)

Categories	Quantification
Yes	-.252
No	3.975



Optimal Scaling Level: Nominal.
Beta: .196.