Peer-to-peer mobility innovations:

Their adoption, use, and associated emissions impacts

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Abstract

The private ownership and use of cars has negative environmental, social, and economic impacts. Peer-to-peer (P2P) mobility innovations challenge the relationship between private ownership and use of cars and could contribute to a more sustainable mobility system.

The research conducted for this PhD explored the adoption and diffusion of P2P mobility innovations and the potential impacts on CO_2 emissions in the UK. P2P ride sharing and P2P car sharing were used as two case study P2P mobility innovations. First, adopter characteristics and the ways in which adopters perceive the attributes of P2P mobility innovations were explored through a survey of 600 adopters and non-adopters. Second, seven in-depth focus groups were conducted with each of the adopter groups identified in the first research chapter. Third, the current emissions impacts of P2P mobility innovations were quantified for each identified type of adopter, and the potential emission reductions under different future scenarios were explored.

Results from the surveys revealed that there are heterogenous groups of adopters of each innovation. These groups differ from each other and from the mainstream population in their sociodemographic and personality characteristics, how they use P2P mobility innovations, and how they perceive the attributes of P2P mobility innovations. Identifying these distinct groups establishes differences in the market potential for P2P mobility innovations. Results from the focus groups revealed that each group differed in how they regard and place importance on the mechanisms of building trust (peer-reputation and reviews, inter-personal relationships, and validation checks), and the targets of trust (trust in peers, trust in the platform, and trust in the product). Users of P2P car sharing placed more importance on trust in the platform, whereas users of P2P ride sharing placed more importance on trust in other people. Trust is vital to the diffusion of P2P mobility innovations and understanding how the identified adopter groups perceive and value trust differently has implications for diffusion strategies. Results from the emissions quantifications revealed that for some adopter groups (commuters using P2P ride sharing), the largest emissions reductions come from using P2P mobility innovations instead of private car use, whereas for other groups (peer-users of P2P car sharing) the largest emissions reductions arise due to forgone vehicle purchases. Results from the future scenario exploration revealed potential emissions reductions of four to seven times larger than current estimates in a high-trust and high-institutional-support future. The scenario analysis contributes to knowledge about how to maximise the largest potential emissions reductions for different adopter groups.

This thesis contributes novel empirical insights into the adopters of P2P mobility innovations. The diffusion potential of P2P mobility innovations is examined and the importance of understanding the diversity of adopters, and their unique contexts, motivations, and perceptions is illustrated. The value of these insights to maximise the potential emissions reductions of P2P mobility are highlighted, and recommendations to platforms and for policy are provided to this end.

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Chapter 1: Introduction

1.1. Research problem and context

The ratification of the Paris agreement in 2016 cemented the international community's objective to limit global average temperature to "well below" 2°C, and to "pursue efforts" to limit this increase to 1.5°C above pre – industrial levels by 2100 (UNFCCC, 2015, p2). In order to achieve these ambitions, there is a pressing need to rapidly reduce CO_2 emissions (Rockström *et al*., 2017). Since 2016, the transport sector has been the largest contributor to UK greenhouse gas (hereafter GHG) emissions (Department for Transport, 2021), contributing 27% of the UK's total emissions (BEIS, 2021). Transport-related GHG emissions are rising faster than any other sector (BEIS, 2017). Over half of these emissions are from private cars (Department for Transport, 2021).

Although climate change is prominent on the political agenda, there is a tendency for decarbonisation efforts to focus on upstream technological processes and incremental efficiency improvements to technology design (Girod and De Haan, 2010). It has been argued that these incremental changes "face diminishing returns in the long term", given their limited diffusion potential (Geels *et al*., 2018, p23). Under this rhetoric, consumers, and consumption, are currently framed as part of the problem (Wilson, 2018). However, Wilson *et al*. (2018) argue that consumption has transformative potential. Changing patterns of consumption offers a potential pathway to reduce CO_2 emissions.

One emerging change to the practice of consumption is the sharing economy. The sharing economy has been described as one of the most significant economic developments of the past decade (Wilhelms, Henkel, and Falk, 2017), and is commonly used as an umbrella term for a variety of business-to-business (B2B), business-to-consumer (B2C), and consumer-to-consumer (C2C) business models (World Economic Forum, 2017). The sharing economy challenges the paradigm of the exclusive use and ownership of goods, and instead promotes a system of access over ownership (sometimes termed "usership"). C2C, in other words peer-to-peer (hereafter P2P), interactions are an emerging area of the sharing economy. While B2C business models have provided traditional rental services to consumers, the growth of the internet has allowed people to share, barter, lend, trade, rent, gift, and swap (Botsman and Rogers, 2010) their personal assets with each other at a previously impossible scale (Selloni, 2017). The sharing economy has been transforming consumption systems and practices globally (Mont *et al*., 2020).

This chapter will first elaborate the context of automobility and the associated climate impacts. Next, the sharing economy and mobility innovations in the sharing economy are

introduced, as a potential mechanism of reducing the emissions impacts of automobility. Finally, this chapter draws these threads together and subsequently presents the outline of this thesis.

1.2. Automobility and emissions

In their seminal work exploring post-car futures, Dennis and Urry (2009) describe automobility as "the mass system of individualised, flexible mobility" (p2). It is estimated that the number of private cars will triple between 2010 and 2050 (International Transport Forum, 2021), reaching around 850 cars per 1000 habitants in 2030 (Dargay *et al*., 2007). As well as an increase in the number of vehicles, it is estimated that the average occupancy rate of cars in the UK is 1.1 – 1.5 persons per vehicle (Department for Transport, 2021). Both the increase in the number of cars and the ways in which they are used (or currently under-used) contribute to the problem of automobility (Correia and Viegas, 2011). Automobility is deeply embedded in lifestyles and is stable as a regime (Kemp, Geels, and Dudley, 2013), where a regime is defined as "a standardised way of doing things" (Geels, 2011, p31).

The current regime of automobility has considerable negative environmental, social, and economic impacts (Goodwin, 2010). From an environmental perspective these include significant contributions to GHG emissions, air pollution and particulate matter which cause significant health impacts (Axsen and Sovacool, 2019). Furthermore, automobility can have other public health impacts. Physical inactivity enabled by automobility is strongly correlated with obesity levels (Kent, 2013). Examples of other negative social impacts of automobility include social inequality (Sandoval *et al*., 2011), and the loss of public space in cities to support the regime of automobility (Urry, 2008).

Despite these problems, transforming the mobility system presents a "nearly overwhelming" cultural, political, and technological challenge (Goodwin, 2010, p61). Private cars offer numerous individual and societal benefits. Private cars are marketed as "the safest, fastest and most comfortable way to negotiate not only traffic but the hectic demands of life" (Kent, 2013, p4). Private cars offer convenience, comfort, and individual freedom in an unrivalled manner (Corriea and Viegas, 2011). However, the decision to own a car is not always a rational choice (Nielsen *et al*., 2015), and private cars carry symbolic, emotional, and cultural attachments. Owning a car is often associated with higher social status, and it has been suggested that cars tend to be attached more to "symbolic and affective motives rather than instrumental and pragmatic ones" (Nielsen *et al*., 2015, p116). There is a socially constructed logic linking "gasoline, cars, and mobility to human flourishing" (Goodwin, 2010, p62).

While much of the research into how to reduce the negative environmental impacts of automobility has focused on technological changes (for example the growing popularity of electric vehicles as an alternative fuel source), this often does not address the social and economic impacts of car ownership. Indeed, Kemp, Geels, and Dudley (2011) find the diffusion of electric vehicles may encourage increased levels of car ownership. As well as technological changes making cars more efficient, there is a pressing need to change the ways that cars are used.

Given the strength of the automobility regime, car-based mobility may be impossible to replace. However, there is a growing emergence of alternative modes of using cars which decouple car ownership from car use (Kent and Dowling, 2013). Personal mobility is undergoing a technological and social change. Electric vehicles, shared mobility, and automated vehicles, collectively referred to as "the three revolutions" (Sperling, 2018, p1), are mobility innovations which have sustainability benefits. These innovations offer the potential for change through new technologies (e.g., EVs), new business models (e.g., B2C and P2P sharing economy business models), and new social practices (e.g., shared instead of private mobility) (Whittle *et al*., 2019). This thesis explores one of these three revolutions – shared mobility.

There are numerous diverse shared-mobility innovations changing how cars are used. Non-private but car-based forms of personal mobility are challenging the current paradigm of the exclusive ownership and use of cars. Axsen and Sovacool (2019) split these into two main types: the sharing of cars (including two-way, one-way, free-floating, and P2P car sharing) and the sharing of rides (including ride sharing, car-pooling, and ride hailing). Furthermore, there are different business models offering shared mobility. The provide different attributes of mobility and appeal to different potential adopters.

Section 1.3 of this chapter explores the sharing economy as an emerging business model providing the framing and context for shared mobility. Next, section 1.4 introduces the two specific shared mobility innovations this thesis explores, which are both alternatives to the exclusive use of private cars.

1.3. The sharing economy

While the concept of sharing is age – old (Frenken and Schor, 2017), the phenomenon of the so-called sharing economy has recently undergone substantial growth in terms of both scale and scope (breadth of assets being shared) (Bocker and Meelen, 2017). The current ubiquity of smartphones and other enabling technologies has aided this trend and has facilitated sharing between strangers (Frenken and Schor, 2017). There is an extensive pool of people with whom to participate in sharing activities (World Economic Forum, 2017). This type of sharing has been described as "impersonal, social sharing", emphasising the point that sharing activities are no longer confined to those within one's own social network (Benkler, 2005, p275). Sharing platforms have also reduced the transaction costs associated with participating in sharing activities, further contributing to the growth of the sharing economy (Fremstad, 2016). Similarly, growing urban populations have also been accredited with facilitating the growth of the sharing economy. This is due to the higher concentrations of under – utilised assets in urban areas and higher population densities, allowing for necessary critical mass effects to take hold (World Economic Forum, 2017) enabled by the physical colocation of peer-providers and peer-users. Finally, it has been suggested that the global recovery from the 2008 economic recession accelerated sharing economy business models in response to the need for frugal spending (Cohen and Kietzmann, 2014).

Despite its current popularity, there is no universally accepted definition of what constitutes the sharing economy, resulting in an ambiguous, and at times seemingly haphazard, usage (Frenken and Schor, 2017). The sharing economy has been described as an "umbrella concept whose boundaries are still blurred" (Selloni, 2017, p16). The term is often confused and conflated in the literature with related business models and consumption practices, including *"*collaborative consumption*"*, *"*prosumption*"*, *"*access/on – demand economy*"*, *"*peer – to – peer economy*"* and *"*zero – marginal cost economy*"*, among others (see World Economic Forum, 2017; Bellotti *et al*., 2015; Botsman and Rogers, 2010).

While various proposed definitions of the sharing economy include B2B, B2C, and P2P business models (Puschmann and Alt, 2016), this research project shall focus exclusively on P2P sharing activities. P2P sharing activities have been described as those "that aim to increase the most widespread participation by equipotential participants" (Bauwens, 2006, p33), and as one of the most disruptive business models within the sharing economy (Cohen and Kietzmann, 2014). P2P business models are recognised as transformative and disruptive in their nature, and they "stand as a permanent alternative to the status quo" (Bauwens,

2006, p34). While B2C and P2P business models are relevant for the wider framing of the sharing economy, a specific focus on P2P interactions is of particular interest due to the aspect of "collaboration" and the high requirements of trust (Mohlmann and Geissinger, 2018) between consumers, who are *de facto* strangers (Huber, 2017). The inter-personal dynamics are a unique feature of P2P business models compared to B2C business models. To this end, it has been argued that "major issues facing the world today, such as protecting the planet, can only be successfully tackled by a P2P economy and thus a P2P society" (Bauwens, 2006, p43).

For the purpose of this thesis, the sharing economy shall refer to ***"consumers granting each other temporary access to under – utilised physical assets ('idle capacity'), possibly for money"***, as defined by Meelen and Frenken 2015 (p.1) In line with this definition, the term sharing economy shall refer exclusively to P2P interactions in this thesis. The notion of "temporary access" excludes second hand and redistribution markets from the concept of the sharing economy, as these instead grant permanent access. This proposed definition of the sharing economy excludes the sharing of other, "non – physical" assets, such as time, skills, or other services. Meelen and Frenken (2015) emphasize the necessity of sharing the idle capacity of physical goods, as, in their view, this is what distinguishes the sharing economy from the on-demand economy (for example, Uber). In the on-demand economy additional capacity is created. The importance placed on idle capacity by this definition of the sharing economy is appropriate given that harnessing idle capacity is regarded as a potential pathway to increasing sustainability (Frenken and Schor, 2017).

The promise of the sharing economy to contribute to a more sustainable model of consumption has been widely discussed and debated (see Bellotti *et al*., 2015; Cohen and Kietzmann, 2014; Heinrichs, 2013, Schor, 2014). It has been proposed that the diffusion of "sharing processes" could confer a marked reduction in the number of goods, without consequential "loss of consumer welfare" (Frenken, 2017, p2). It is often assumed that the sharing economy can contribute towards CO_2 emission reductions through a reduction in overall consumption and subsequent resource use (Curtis and Lehner, 2019; Geissinger *et al.,* 2019). On the other hand, it has also been suggested that sharing economy as a business model may increase CO_2 emissions either through direct or indirect rebound effects (Skjelvik *et al*., 2017), and a trend towards "professionalisation" increasing emphasis on consumption under the guise of the sharing economy (Geissinger *et al.,* 2019). Most research into the potential sustainability benefits of the sharing economy takes an idealistic approach, and there is a lack of evidence exploring the causal mechanisms herein. The realised

sustainability benefits of the sharing economy remain poorly understood (Mont *et al*., 2020). Against the backdrop of COVID-19 recovery, the climate crisis, economic uncertainty, and loss of social connectedness, there is a pressing need to understand and advance sustainable sharing economy practices (Mont *et al*., 2020).

1.4. Peer-to-peer mobility in the context of the sharing economy

P2P car sharing and P2P ride sharing are two emerging mobility innovations, within the framing of the sharing economy. Both ride sharing and car sharing are capitalising on the idle capacity associated with private vehicle ownership. P2P car sharing and P2P ride sharing decouple ownership and private use of cars through different business models.

It has been estimated that private cars are used on average 5% of the time (Burns and Shulgan, 2018). P2P car sharing harnesses this idle capacity. In the UK 65% of all car journeys are single-occupancy, and 89% of commuters who commute by car drive alone (Department for Transport, 2021). The average occupancy rate across all journey purposes in the UK is 1.5, and for commuting it is 1.1 (ibid.). P2P ride sharing harnesses this idle capacity, in the form of empty passenger seats. Both P2P mobility innovations will be introduced in the next section.

P2P car sharing
An individual provides temporary access of their car to another individual often for payment.

P2P ride sharing
A driver shares a journey in their own car with passengers.

Figure 1: A visual representation of P2P car sharing and P2P ride sharing.

1.4.1. P2P car sharing

P2P car sharing describes the act of an individual granting temporary access of their vehicle to another individual, often for payment. P2P car sharing is a 'product-service' system, in that it combines an asset (a car) and a service (access to a car) (Schaefers, 2013). In the context of car sharing, emerging P2P business models have been described as "one of the most disruptive types of business model" (Cohen and Kietzmann, 2014, p279), and P2P car sharing has grown rapidly, with one study estimating a 200%-300% annual growth rate since 2012 (Meelen *et al*., 2019). While the perceived benefits from the viewpoint of a peer-user may be similar for P2P car sharing and B2C car sharing, P2P car sharing has lower operating costs, a wider potential distribution, and a reduced demand for land in urban areas (e.g., designated parking spaces) than B2C car sharing (Shaheen, Mallery, and Kingsley, 2012). This could mean a greater diffusion potential, and different and wider societal benefits of P2P car sharing compared to B2C car sharing. However P2P car sharing differs from B2C car sharing because transactions occur between individuals with asymmetrical information. Increased economic risk for both peer-users and peer-providers and a dependence on interpersonal trust are inherent to the P2P business model (Hartl *et al*., 2018; Wilhelms *et al*., 2017). Various digital platforms facilitating the P2P sharing of personal vehicles are fully operational worldwide, including: Hiyacar (UK), Snappcar (Netherlands), Getaround (USA), OuiCar (France), Drivy (France), Turo (USA), RelayRides (USA).

1.4.2. P2P ride sharing

P2P ride sharing and carpooling are terms which appear to be interchanged and conflated in the literature, although Cohen and Kietzmann (2014) draw the distinction that carpooling refers to the same individuals repeatedly travelling in the same vehicle together (for example for commuting), whereas ride sharing refers to one – off journeys. P2P ride sharing is a service-system, as it connects peer-providers (who provide the service of mobility) with peer-users (who use the service of mobility). The emphasis placed on "idle capacity" distinguishes P2P ride sharing services from ride – hailing or on – demand taxi services, such as Uber and Lyft (Frenken and Schor, 2017). Uber is often claimed to be a part of the sharing economy, however unless the driver would have made the same trip anyway (thus utilising the idle capacity of the empty seats in the vehicle), capacity is instead created through the consumer demand for the journey (Meelen and Frenken, 2015). P2P ride sharing platforms include Blablacar (Europe), Liftshare (UK), Sidecar (USA), GoCarShare (UK), Toogethr (Netherlands).

1.5. Implications and thesis outline

Despite the optimism that P2P mobility innovations could challenge the regime of automobility and reduce transport emissions, it has been argued that "too little of the research in this field has focussed on behavioural realism" (Axsen and Sovacool, 2019, p2). There remains "considerable uncertainty" about the diffusion potential of these innovations and the environmental impacts that these could cause (ibid.). This uncertainty is attributed to a lack of research into the actual adopters of P2P mobility innovations (ibid.). Understanding who the potential adopters of P2P mobility innovations are, why they choose to use P2P mobility, and the factors that may influence that over time is imperative to understanding the realistic potential sustainability impacts that the diffusion of P2P mobility innovations could have.

The research in this thesis addresses these uncertainties and aims to develop an understanding of the adoption, use, and GHG impacts of P2P mobility. The first three chapters of this thesis set the context for the subsequent empirical research chapters. This first chapter introduced the topic of P2P mobility in the context of the sharing economy, and as a potential pathway to reducing transport-related emissions. A summary and review of the existing academic literature is presented in chapter 2. The Diffusion of Innovations theory and a framework contextualising trust in the context of the sharing economy are introduced. Key research on the adopters of P2P mobility and the sustainability of P2P mobility is discussed. The gaps in the literature are identified. Chapter 3 details the specific research questions for this thesis, addressing the identified gaps in the literature. The research design and the justification of the P2P mobility schemes explored in the empirical chapters are described. Chapters 4, 5, and 6 present the empirical research of this thesis. Chapter 4 explores the characteristics of adopters using quantitative survey analysis. Chapter 5 investigates the role of trust in P2P mobility using qualitative focus groups. Chapter 6 quantifies the emissions impacts under current trajectories and different future diffusion scenarios. Finally, chapter 7 presents an overall discussion and summarises the main conclusions, recommendations for supporting the diffusion of P2P mobility, and suggests possibilities for future research.

Chapter 2: Literature review

Chapter 1 set P2P mobility in the context of automobility and introduced the two P2P mobility innovations which will be the focus of the empirical research for this thesis: P2P car sharing and P2P ride sharing. The aim of this chapter is to review the existing literature and identify appropriate theoretical frameworks for the framing of this thesis. This chapter will conclude by summarising the gaps in the current knowledge and set the context and rationale for the empirical research of this thesis.

2.1. Adoption and diffusion of P2P mobility innovations

The diffusion potential of P2P car sharing is debated and there is conflicting evidence in the literature. Estimates of the percentage of car owners who would be willing to rent their personal vehicles to others on a P2P car sharing platform range from 50% (Frost and Sullivan, 2015) to 19% (Wilhelms *et al*., 2017) and 20% (Kamargianni *et al*., 2018). On the other hand, it has been suggested that up to 50% of non-car owners would consider using P2P car sharing to access a car (as a peer-user) (Kamargianni *et al.,* 2018). In the context of P2P ride sharing, 55% of UK adults state that they would be willing to join a workplace-based scheme for commuting (University of Essex, 2022).

Diffusion of Innovations theory (DOI) by Everett Rogers was first published in 1962 and is the most influential publication on diffusion research (Sriwannarit and Sandstrom, 2015). The concept of diffusion is defined as "the process by which an innovation is communicated through certain channels over a period of time among the members of a social system" (Rogers, 2003, p11). There are four main elements to DOI: the innovation itself, the communication channels, time, and the social system. DOI will be used as a framework to explore how and why people adopt P2P mobility.

The innovation-decision process is a five-stage process which describes how an individual goes from gaining first knowledge of an innovation (knowledge), to forming an opinion of the innovation (persuasion), to deciding to adopt or reject the innovation (decision), to deciding to implement the innovation (implementation), and finally seeking confirmation of the innovation – decision already made, open to ultimately changing this (confirmation) (Rogers, 2003). This process is illustrated in Figure 2. A decision to adopt is not made instantaneously. The innovation-decision process is described by Rogers as a series of choices and actions over time during which the decision-making unit decides whether to adopt and continue using an innovation (Rogers, 2003). The model draws upon other elements of DOI (the attributes of an innovation, adopter characteristics, prior conditions),

detailing how these different elements of DOI interact at different stages and lead to the ultimate adoption or rejection of an innovation.

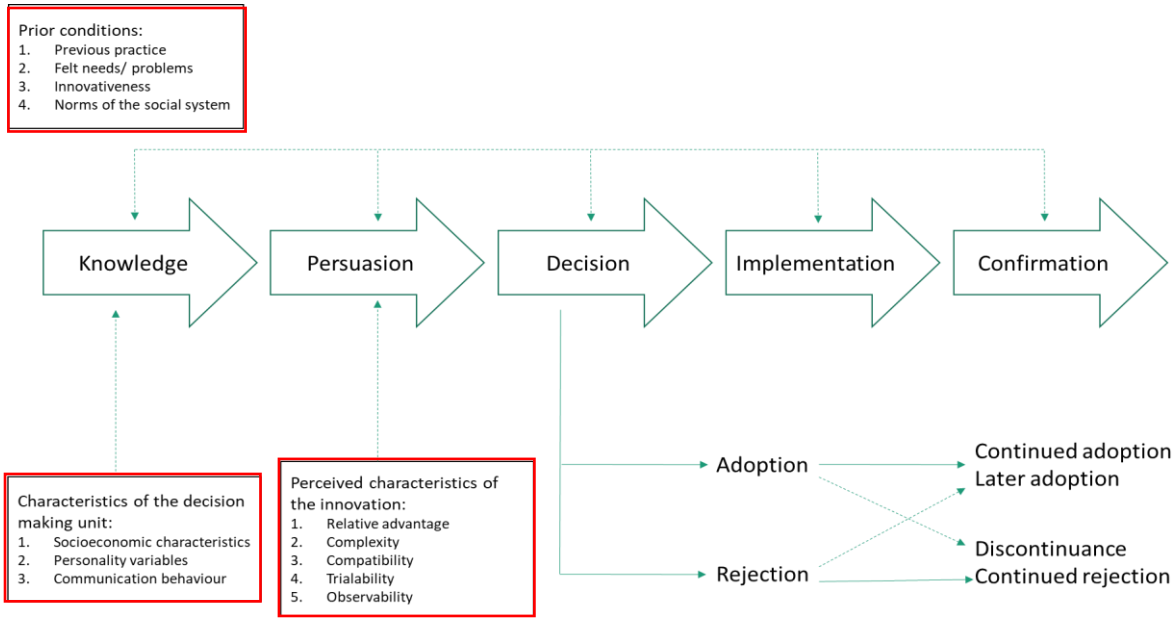

Figure 2: The five stages of the innovation-decision process.

This chapter will review the literature exploring the different elements of DOI which will be drawn upon in subsequent chapters, including the perceptions of the innovations' attributes, adopter characteristics, and prior conditions to adoption. The elements of DOI which will be used in this thesis are identified by red boxes in Figure 2. The current literature exploring these elements will be reviewed in the rest of this section.

2.1.1. Adopters' perceptions of the attributes of P2P mobility innovations

Rogers defines an innovation as "an idea, practice, or object that is perceived as new by an individual or another unit of adoption" (Rogers, 2003, p12). The rate of adoption of an innovation is heavily influenced by how its characteristics are perceived by individuals. There are 5 key attributes of innovations which can predict its rate of adoption: its relative advantage, compatibility, complexity, trialability, and observability. It is potential adopters' perceptions of these attributes which predict an innovation's rate of adoption, and therefore innovations only need to be perceived as being better than the incumbent to be successful (Hardman *et al.*, 2016). There are no known studies which use DOI as a framework to explore adopters' perceptions of the attributes of P2P mobility. Despite this, using DOI can provide important insights into how adopters perceive the attributes and the impacts that this could have on the widespread adoption and diffusion of P2P mobility. This section will introduce

the five key attributes of innovations and review the literature exploring these with relation to P2P mobility innovations.

The relative advantage of an innovation is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 2003). The relative advantage is one of the strongest predictors for the adoption rate of an innovation and is the most important consideration for early adopters (Rogers, 2003). Both peer-providers and peer-users of P2P car sharing and P2P ride sharing cite potential financial benefits as a main motivation for participating in shared mobility innovations (Wilhelms *et al*., 2017; Shaheen, Mallery and Kingsley, 2012; Amirkiaee and Evangelopoulos, 2018). However, these financial benefits take different forms. Peer-users have the potential to save money through using P2P mobility instead of alternatives. On the other hand, peer-providers potentially earn money.

Wilhelms, Merfeld, and Henkel (2017) find that there are three "prototypical" types of P2P car sharing peer-provider, who differ in their perceptions of the financial benefits of adoption. They identify "cost-conscious" adopters, who adopt P2P car sharing to offset some of the costs associated with car-ownership; "spenders" who adopt P2P car sharing to generate additional disposable income to enrich their own quality of life; and "sharers", who adopt P2P car sharing for more social motives of providing mobility for others. However, this contradicts findings from Münzel *et al*., (2019), who propose that the potential financial rewards from renting out their vehicle do not incentivise people to adopt P2P car sharing. Regarding peer-users, Wilhelms, Merfeld, and Henkel (2017) propose that there are four prototypes: the budgeters (saving money through using P2P car sharing), the convenience-lovers (saving time and reducing hassle compared to traditional B2C car rental), the status-conscious (using P2P car sharing to signal social status), and the assurance-seekers (using P2P car sharing to get the specific mobility experience they desire).

Wilhelms, Merfeld, and Henkel (2017) propose that peer-users typically use P2P car sharing around once per month, and they propose that P2P car sharing "has evolved to fill the gap" between traditional B2C car rental in which cars are rented for typically longer periods (multiple days), and B2C car sharing business models (e.g., one-way and two-way car sharing) in which cars are typically rented for shorter periods (hours). However, these characteristic prototypes are based solely on use characteristics and motivations, and the authors do not explicitly consider the role of sociodemographic factors in predicting adoption.

Similar to P2P car sharing, expected financial benefits are identified as a contextual attribute which incentivises adopters of P2P ride sharing (Amirkiaee and Evangelopoulos, 2018).

Shaheen *et al*. (2017) explored the perceptions and characteristics of adopters of P2P ride sharing in France, finding that both peer-providers and peer-users cite the financial benefits of P2P ride sharing as their main motivating factor. However, the perceptions of the relative advantage differed. Peer-users in the lowest income bracket perceived that they had no alternatives, and this drove their decision to adopt P2P ride sharing. Furthermore, lower-income adopters used P2P ride sharing more frequently than higher-income adopters, due to the reduced number of alternatives available to the lower-income adopters. The authors conclude that P2P ride sharing can be conceptualised as a "dual-practice", based on the different perceptions and socio-demographic characteristics between different user segments.

In addition to the perceived financial benefits, peer-users of P2P ride sharing value the perceived time saving benefits and the perceived sustainability benefits. These can be framed as perceived relative advantages of using P2P ride sharing. Furthermore, Amirkiaee and Evangelopoulos (2018) find that while commuting in single-occupancy vehicles can be a stressful activity, commuting with others through P2P ride sharing has a "stress-mitigating effect" (p14). This arises due to the social nature of P2P ride sharing.

However, Kamargianni *et al*. (2018) investigate the perceptions of people living in London towards car-ownership and different car sharing business models. They find that, while most respondents state that they see the benefits of car sharing schemes, only 20% of car-owners in London would consider listing their personal cars on a P2P car sharing platform. The authors suggest that this apparent contradiction can be explained by people's emotional attachment to their personal vehicles, and the perceived social norm of private car ownership in the regime of automobility. This demonstrates that there are barriers to adoption of P2P mobility beyond the perceived attributes.

The compatibility of an innovation is defined as the degree to which innovations are perceived as being consistent with the existing values, previous experiences, and needs of potential adopters (Rogers, 2003). Innovations which are less compatible with the values and norms of a social system are slower to be adopted. At the individual level, adopters use their existing understanding and knowledge of an innovation to make comparisons with what they already know (Hardman, 2016). Previous research has found that the perceived compatibility of shared mobility innovations (P2P ride sharing and B2C car sharing) with daily life is the most important factor in predicting adoption (Burghard and Scherrer, 2022). Wilhelms, Henkel, and Merfeld (2017) propose that there are four overarching values that

P2P car sharing peer-providers are pursuing, which they identify as "earn (economic interest)", "quality of life (enjoy)", "help others (enrich)", "sustainability (enhance)". They argue that P2P car sharing users are not only concerned with the financial benefits of P2P car sharing but are also motivated by being able to express their personalities through the cars they offer.

The complexity of an innovation is the degree to which an innovation is perceived as being difficult to understand and use (Rogers, 2003). If an innovation is easy to understand and simple to use it will be more attractive to adopters. Innovations which are complex, and where it is difficult to communicate the features and benefits of them are slower to diffuse through the social system.

The trialability of an innovation is the degree to which an innovation may be used on a limited basis before committing to using it (Rogers, 2003). The easier it is to trial an innovation, the more likely it is that that innovation will have a faster rate of diffusion. Being able to trial an innovation before fully adopting it can help reduce the perceived risks and increase an understanding of its other attributes.

Finally, the observability of an innovation is the degree to which the results of using the innovation are visible to others. Innovations which have a higher degree of observability are more likely to diffuse faster through the social system. Observability is important for reducing perceived risks and uncertainties (Rogers, 2003).

Both peer-providers and peer-users of P2P car sharing are more likely to have used other forms of shared mobility compared to the general population (Münzel *et al*., 2019; Barbour *et al*., 2020; Ballús-Armet *et al*., 2014). This could suggest that the perceptions of the attributes of different shared mobility innovations overlap to some extent and provide a greater perception of the observability of P2P mobility. They propose that an adopter of another shared mobility innovation is more likely to see how P2P car sharing could be compatible with their values and needs.

2.1.2. Adopter characteristics

Not everyone in a social system adopts an innovation simultaneously. Rogers identifies five adopter categories, each with distinguishing characteristics. These adopter categories differ in their degree of "innovativeness", which is the main dependent variable in diffusion research. The adopter categories are ideal types, in that while they are based on observations of adopters, there will be some exceptions. The purpose of portraying these

adopter categories as ideal types is to enable comparison between them (Hardman, 2016). The five ideal types are characterised below:

1. Innovators: venturesome, interested in trying new ideas, risk takers
2. Early adopters: represent opinion leaders, embrace change, respectful of peers
3. Early majority: deliberative, rarely leaders, but do adopt before the average person
4. Late majority: sceptical of change, need pressure from peers to motivate adoption
5. Laggards: localite outlook, bound by tradition

The proportion of adopters that fall into each category is stylised as a normal distribution (Figure 3).

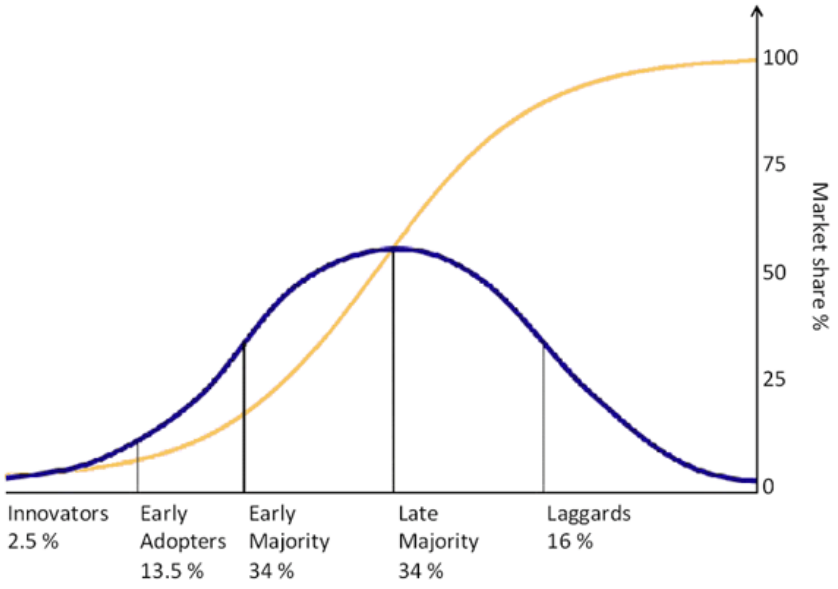

Figure 3: The distribution of the five adopter groups, and the subsequent market share of an innovation as each group adopts the innovation.

The different characteristics of the adopter categories demonstrates the difference between earlier adopters and later adopters of an innovation. "Early adopters put their stamp of approval on a new idea by adopting it" (Rogers, 2003, p283). Early adopters are considered role models in their networks who play an essential role in the diffusion of innovations. Identifying and understanding the types of people who are likely to adopt P2P mobility innovations is vital to understand their diffusion potential. Early adopters play a pivotal role in the diffusion of innovations and are more likely to be opinion leaders and change agents (Rogers, 2003), where opinion leaders are perceived as credible sources of trusted information able to informally influence the attitudes of others (Rogers, 2003).

Rogers makes generalisations about the socio-economic profiles, personality values, and communications behaviours of each adopter group. Early adopters typically have more years of formal education, have a higher social status, and have a greater degree of upward social mobility. However, there is inconsistent evidence about the relationship between age and innovativeness (Rogers, 2003). The personality variables associated with innovativeness are not as widely researched, however it is expected that early adopters have greater empathy, may be less dogmatic, higher levels or rationality and intelligence, and a higher ability to cope with change and uncertainty and risk (Rogers, 2003). Finally, early adopters generally have more social participation and connectedness with others, are more "cosmopolite" (Rogers, 2003 p.290), have a higher degree of opinion leadership, and have greater exposure to different communication channels.

The existing literature exploring early adopter characteristics tends to focus solely on one adopter group (i.e., either peer-users or peer-providers), or treat both peer-roles as one homogenous group. In the case of car sharing, most literature focusses on B2C business models, and the literature focussing on P2P models is comparatively limited (Münzel *et al*., 2020). A similar trend is apparent in the P2P ride sharing literature. There is a conflation of ride hailing and ride sharing in the literature, whereas this thesis recognises these as distinct innovations and focusses on just ride sharing, in line with the definition in chapter 1.

There are distinct types of P2P ride sharing each of which have potentially different groups of adopters. Chan and Shaheen (2012) propose three main types of P2P ride sharing: ad hoc, organisation-based, and acquaintance-based. Despite these identified subgroups, most of the literature into the adopters of P2P ride sharing focusses solely on commuters, with very little current research into the adopters of one-off P2P ride sharing. Furthermore, even when all forms of P2P ride sharing are considered together, it has been noted that the literature exploring adopters and their motivations is limited (Chan and Shaheen, 2012; Shaheen and Cohen, 2019).

Studies exploring the characteristics of adopters of P2P car sharing have found that they are more likely to be younger (typically characterised as 25-34, or 25-40), have more education, and have higher incomes than the average population (Dill *et al*., 2017; Wilhelms *et al*., 2017; Shaheen *et al*., 2018). Kamargianni *et al*. (2018) similarly find that younger people are more likely to adopt P2P car sharing.

Similar trends have been found in studies exploring the sociodemographic characteristics of adopters of P2P ride sharing. Adopters in general are typically younger (under 35), have

more years of formal education, and have average incomes similar to the rest of the population (Shaheen *et al*., 2017). However, Shaheen *et al*. (2017) also compared the incomes of adopters who typically use P2P ride sharing as a driver and those who use it as a passenger. Drivers had significantly higher incomes than passengers, and this correlates with higher levels of private car ownership. However, Alberto Molina *et al*. (2020) found that sociodemographic characteristics were "limited" in explaining adoption of P2P ride sharing for commuting. They found that comfort and safety (which could be framed as relative advantages) were more important predictors. Furthermore, interventions from the workplace encouraging or enforcing adoption is proposed as an additional reason why sociodemographic characteristics are not strong predictors of adoption of commuting by P2P ride sharing.

There is conflicting literature about the impacts of gender on the propensity to adopt P2P car sharing. Dill *et al*. (2017) suggest that women are more likely than men to be peer-users. Julsrud and Farstad (2020) find that single people and couples (compared to families with children) are more likely to use P2P car sharing than B2C car sharing. From a peer-provider perspective, Shaheen *et al*. (2018) find that men are more likely to adopt P2P car sharing, and similarly Barbour *et al*. (2020) find that women are significantly less likely to adopt P2P car sharing as a peer-provider. Barbour *et al*. (2020) also find that peer-providers are also less likely to live in a one-person household. They suggest that one-person households have a higher dependency on their personal vehicles. On the other hand, Prieto *et al*. (2017) find that males living in one-person households are most likely to be peer-users of P2P car sharing. They suggest that single males are less likely to have personal safety concerns which prohibit them from adoption and more flexibility in coordinating pick-up and drop-off times. In contrast with the previously reviewed literature, the authors also find no correlation between education level and propensity to adopt P2P car sharing. However, this could perhaps be explained by the fact that Prieto *et al*. (2017) only explore the propensity to be a peer-user of P2P car sharing, and not a peer-provider. Furthermore, they found that other sociodemographic variables (including income, education level, being employed) were not correlated with propensity to be a peer-user of P2P car sharing. They propose that P2P car sharing is compatible with different types of potential consumers, and that this could facilitate its widespread diffusion.

Similarly, there is conflicting literature about the impact of gender on propensity to adopt P2P ride sharing. Caulfield (2006) and Delhomme and Gheorgiu (2015) found that women are more likely to rideshare than men. These findings contradict those of Hagag *et al*. (2018),

who explored adopters of P2P ride sharing in different Canadian cities and found that men are more likely to be adopters than women.

There is a lack of research comparing peer-providers and peer-users of P2P car sharing and little understanding how these two different adopter groups of the same innovation compare in their characteristics. Münzel *et al*. (2019) suggest that P2P car sharing peer-users have comparatively lower incomes than peer-providers. They also propose that peer-users of P2P car sharing opt to use P2P car sharing over B2C car sharing given that it is typically cheaper. P2P car sharing offers a "low-cost entry" to private car usage, and therefore has been found to appeal to individuals with lower incomes (Thurner, 2022, p414).

Ciari and Axhausen (2013) found four distinct clusters of attitudes towards P2P ride sharing for one-off journeys. They characterised these clusters as: negative non-interested, pragmatic, sceptical environmentalist, enthusiastic environmentalist. The sociodemographic characteristics of the enthusiastic adopter cluster match Rogers' expectations; they are typically younger, have a higher income and have a higher level of education compared to the general population. They have larger likelihood of living in a car-free household. The authors find that this cluster are not concerned about the "practical issues" of P2P ride sharing and are persuaded that the platforms function properly. However, the authors propose that the diffusion of P2P ride sharing is dependent on platforms appealing to the pragmatic and the sceptical environmentalist clusters in addition to the concerned environmentalists. They suggest that these two clusters are more representative of the general population and their adoption is therefore crucial to the long-term success of P2P ride sharing. It is important to highlight that while the authors find more than half of the respondents state they would be willing to use P2P ride sharing, the actual percentage of respondents who intend use P2P ride sharing is smaller.

Correia and Viegas (2011) explored perceptions of a proposed "carpooling club". The authors identified two main barriers to the adoption of carpooling for commuting: a lack of interpersonal-trust and concerns about travelling with strangers, and a lack of suitable matches (people who are travelling to the same destinations at the same times). They proposed a carpooling club to alleviate these concerns while gaining the benefits from P2P ride sharing. They found that younger people are more likely to join a carpooling club, but they do not find any effects of gender. Furthermore, they find that propensity to join a carpooling club is associated with lower incomes and specific employment positions ("not white collar" and not "managerial roles"), which they summarise as "lower socio-economic

classes" (p88). Similarly, Vanoutrive *et al*. (2012) propose that P2P ride sharing for commuting is most prominent among people working in the construction and manufacturing sectors.

Furthermore, Correia and Viegas (2011) found that people who live in households with access to multiple cars are more likely to adopt. In addition, the authors find that people who have difficulty parking at work (through limited availability or high costs) are more likely to commute by carpooling club, as they view this as more of an incentive. These results are similar to those found by Caulfield (2006), who investigated perceptions towards commuting by ride sharing in Dublin. They also found that a person's occupation significantly impacted their decision to commute by P2P ride sharing. They found those in skilled and in manual industries were significantly more likely to ride share. On the other hand, people who were employed as professionals or in management were significantly less likely to ride share. They also find that younger people (under 40) are more likely to rideshare.

Nielsen *et al*. (2015) conducted interviews and focus groups to explore perceptions to P2P ride sharing for commuting. They describe a person who is likely to commute by P2P ride sharing (as a passenger) as a "calculating deliberator", characterised as non-car owners who "calculate the costs and benefits of different travel modes – public, private, shared, single – and will decide based on cost" (p.120). This characterisation draws together one socio-demographic factor - non-car owners, and one motivational factor – financial savings and costs. However, the authors respondent sample comprised of less than 20% who had previously used P2P ride sharing.

Hagag *et al*. (2018) find that adopters of P2P ride sharing are more likely to live in urban or semi-urban areas and propose that adoption of P2P ride sharing is both dependent on "*who* you are" as well as "*where* you are". This need for a critical mass supporting adoption of P2P ride sharing is also explored in other literature (see Wells *et al*., 2020). On the other hand, in the case of P2P car sharing it has been proposed that adopters are not confined to urban locations (Meelen *et al*., 2019). The authors compared the spatial distribution of P2P and B2C car sharing in the Netherlands and found that B2C car sharing was confined to major urban areas, while P2P car sharing "can occur anywhere car owners live" (ibid., p138).

2.1.3. Social communication

Communication is the process by which individuals create and share information with each other. Communication channels are the means by which "messages get from one to another" (Rogers, 2003, p18). Rogers describes innovation as a social process involving

interpersonal communication relationships and recognises that communication from adopters to non-adopters is a vital mechanism for informing non-adopters of the innovations' attributes and reducing uncertainties and risks (Rogers, 2003). On the other hand, adopters can also communicate negative perceptions and experiences of innovations. Interpersonal communication of negative perceptions and experiences of innovations can hinder diffusion. Valor (2020) found evidence of adopters of P2P car sharing increasing uncertainties among potential users through communicating their anticipated stress and anxiety about renting out their private car on P2P car sharing platforms.

The sharing economy can be considered a social innovation (Martin and Upham, 2016). Previous research has found that various pro-social factors influence a persons' propensity to participate in the sharing economy. These pro-social factors include trust towards other people, sociability, novelty-seeking, and social norms (Malecka *et al*., 2022). Related to the concept of sociability, the personality traits of extraversion, openness, and agreeableness have been found to be associated with propensity to adopt shared mobility innovations (Spurlock *et al*., 2019).

In the case of commuters who use P2P ride sharing to travel to work, there is evidence that perceived social norms and social pressure to conform can influence peoples' decision to use P2P ride sharing (Bachmann *et al*., 2018).

Social aspects can also be an important outcome of the adoption of P2P mobility. Alberto Molina *et al*. (2020) find that socializing is the most important reason for adopters to commute by P2P ride sharing. Similarly, Agatz *et al*. (2012) propose that there are social benefits from commuting by P2P ride share and that it enlarges adopters' social networks.

This section has reviewed the current literature which explores the adopters of P2P mobility innovations, using elements of DOI as a framework. While the literature does reveal some similarities between the adopters of P2P ride sharing and P2P car sharing, there are equally differences between these two groups and uncertainties. Furthermore, the literature reviewed has demonstrated that DOI has not been systematically used as a framework for framing the different elements which explore the diffusion of P2P mobility innovations.

2.2. Trust in the context of the sharing economy

Early adopters play a key role in the diffusion of innovations, by sharing trusted knowledge and information with members of their social networks (Berger, 2016). Interpersonal trust is "implicit and central" within the DOI framework (Vrain *et al*., 2022, p3). In the context of

the sharing economy, trust is vital for the adoption and continued use of an innovation (see ter Huurne *et al*., 2017). These decisions occur during the implementation and confirmation phases of the innovation-decision process in DOI. Mohlmann and Geissinger (2018) propose that trust in the context of the sharing economy stems from interpersonal relationships "that expand outwards in a radius of trust" (p3).

Trust has been described as the most important driver to the long-term success of the sharing economy (Cook and State, 2015; Botsman and Rogers, 2010), and even as "the lubricant of the sharing economy" (Bossauer *et al*., 2020, conference abstract). In their 2010 seminal book on the sharing economy as a business model, Botsman and Rogers describe trust as "the currency" of the sharing economy. Furthermore, a lack of trust, the perceptions of risks, and information asymmetries have been suggested to be the main blockers to consumers participating in the sharing economy (Gimpel, Hawlitschek, and Teubner, 2017; ter Huurne *et al*., 2018). Similarly, Barnes and Mattsson (2016) propose that establishing trust is the largest barrier to participating in the sharing economy.

Despite the recognised and accepted importance of trust in the sharing economy, Raisanen *et al*. (2021) highlight the definitional ambiguity in this emerging field of literature. They conducted a literature review of how trust is built in the sharing economy, however they highlight that less than half of the studies they review provide a definition of "trust". This is noted as a worrisome finding and suggest that future research set out clear definitions and expectations of what "trust" incorporates. The authors also find definitional ambiguity of the term "the sharing economy" and note that different authors use it to describe different business models, including the on-demand economy, the gig-economy, B2C sharing economy, and P2P sharing economy. They find that different research fields tend to use different interpretations of "the sharing economy" and call for future research to clarify the definitions and scope of "the sharing economy". This definitional ambiguity has large implications for researching trust in the context of the sharing economy.

Digital platforms facilitate trust-building between strangers. Many P2P platforms operate reputation systems, encompassing ratings and reviews, to build and maintain trust between peers (Teubner and Dann, 2018). In this way, users of P2P platforms develop a digital reputation accumulated by other users of a platform (Mohlmann and Geissinger, 2018). Furthermore, having reputation systems in place provides reassurance that users can sanction others if they behave in a way which violates the principles of the platform (Dellarocas, 2003). Numerous authors have found that reputation systems, and in particular

having a positive reputation, positively influences perceptions of a user's trustworthiness. Having a positive online reputation can result in greater financial gains for the peer-provider (Ikkala and Lampinen, 2014). For example, Teubner *et al*. (2017) explore the relationship between online reputation (based on: number of ratings, average rating score, duration of membership, verified ID, "superhost" badge, and number of photos) and the price effects of AirBnB hosts. The authors find that an AirBnB host's reputation significantly impacts their listing prices; an increase in the hosts' ratings by one star increases the price by $18; each additional month that the host has been a member of AirBnB increases price by $0.5; and each additional photo of the AirBnB increases expected price by $1. Contrastingly, Ert *et al*. (2016) explore the impact of photos of peer-providers of AirBnB (of their faces not of the accommodation) on how trustworthy they are perceived to be by other users. The find that the number of ratings and average ratings scores has no impact on price listings or the likelihood of peer-users booking their accommodation. On the other hand, they find that the more trustworthy a peer-provider is perceived to be in their photo, the higher the listing price and the more likely their accommodation will be rented. They propose that this effect is caused by peer-users desire for personal contact. They propose that providing personal photos is another method to increasing online reputations and increasing others' perceptions of trust. However, Zervas *et al*. (2021) explore the influence that ratings have, as a mechanism for building trust through electronic word-of-mouth (eWOM) and find that the average rating is 4.7 stars (out of 5). Furthermore, over 94% of all AirBnB properties have a rating of 4.5 or higher. They propose that leaving a rating on a P2P platform is more "personal" than leaving a review of a B2C company, suggesting why most ratings are high. Despite the inflation of ratings, over 70% of platform users stated that they trust online ratings.

Mohlmann (2016) conceptualises trust in P2P transactions in two-dimensions: trust in peers, and trust in the platform. She states that trust in the context of the sharing economy is "a hierarchical, two-fold world" (p23). Trust in the platform encompasses the norms, rules, principles, and expectations of the platform, and this was found to have a mediating effect on trust in peers. Trust in the platform influences perceptions of trust in the other users. Mohlmann argues that trust in the platform should therefore be regarded as the more focal target of trust. To this end, Ter Huurne *et al*. (2017) suggest that one of the most important ways a platform can earn a user's trust is through the use of security measures, including authentication, encryption, and integrity. In addition to security measures, guarantees,

website quality, service quality, and the reputation of the platform were all found to be important in shaping users' perceptions of trust in the platform.

Mohlmann and Geissinger (2018) frame trust within social networks as intertwined with social capital, using the definition of social capital as "it inheres in the structure of relations between and among actors" (p34). They draw parallels between trust in the context of very close social contacts and trust in digital networks (including members of online P2P platforms) both drawing on perceived social capital as the key to trusting others. Furthermore, they propose that digital trust cues, such as ratings and review systems, facilitate the development of social capital.

Despite the generally accepted importance of trust in the adoption of sharing economy practices, in their 2017 literature review on the concept of trust in the sharing economy, ter Huurne *et al*. conclude that there is a considerable lack of research into trust in the sharing economy. Furthermore, they identify that most literature focuses on trust from the perspective of the peer-user and not the peer-provider and call for future works to take the peer-providers' perspective. Indeed, Ter Huurne *et al*. (2018) suggest that peer-providers often face larger risks and must also overcome a trust barrier. The success of the sharing economy is dependent on different adopters performing complementary peer-roles to complete a transaction (PwC, 2015). Both of these peer-roles will have their own distinct requirements of trust, targeted to other users and the mediating platform. Indeed, Hawlitschek, Teubner, and Weinhardt (2016) find that peer-providers place a greater emphasis on trust in the platform, whereas peer-users place greater emphasis on trust in other users.

Hawlitschek, Teubner, and Weinhardt (2016) conceptualise a framework of trust in the sharing economy. Similar to the literature review by ter Huurne *et al*. (2017), they identified that the existing research models used to explore trust in the context of the sharing economy mostly focussed on either the peer-user perspective or the peer-provider perspective. Only one previous research model focussed on both of these perspectives (see Leonard, 2012). Furthermore, there were notable differences between what the "targets" of trust were in these research models. Most previous research models explored other users ("peers") as the target of trust. Two research models explored the mediating platforms as the target of trust (see Gefen and Straub, 2004; Lu *et al*., 2010). However, there were no previous models exploring the product being shared as a target of trust.

The research model proposed by Hawlitschek, Teubner, and Weinhardt (2016) distinguishes three targets of trust: peers, platform, and product. The authors also distinguish three dimensions of trust; the *ability* to safely complete the transaction, the *integrity* of the target of trust to "keep their word", and the *benevolence* of the target of trust to keep the others' interests in mind. Finally, they differentiate these dimensions and targets of trust from the perspectives of the peer-user and the peer-provider. The authors state that they "present [our] conceptual research model as a simplified basis for future research" (p7).

This thesis uses the conceptual model proposed by Hawlitschek, Teubner, and Weinhardt (2016) as a framework for exploring trust in the context of P2P mobility. This conceptual framework is presented in Figure 4. This research framework highlights the separate perspectives of the peer-user and peer-provider, and how trust results in different intentions: the intention to consume and the intention to supply respectively. Indeed, the sharing economy as a business model is dependent on having adopters perform both peer-roles in order to complete a transaction. Therefore, this framework takes a holistic approach to conceptualising the sharing economy.

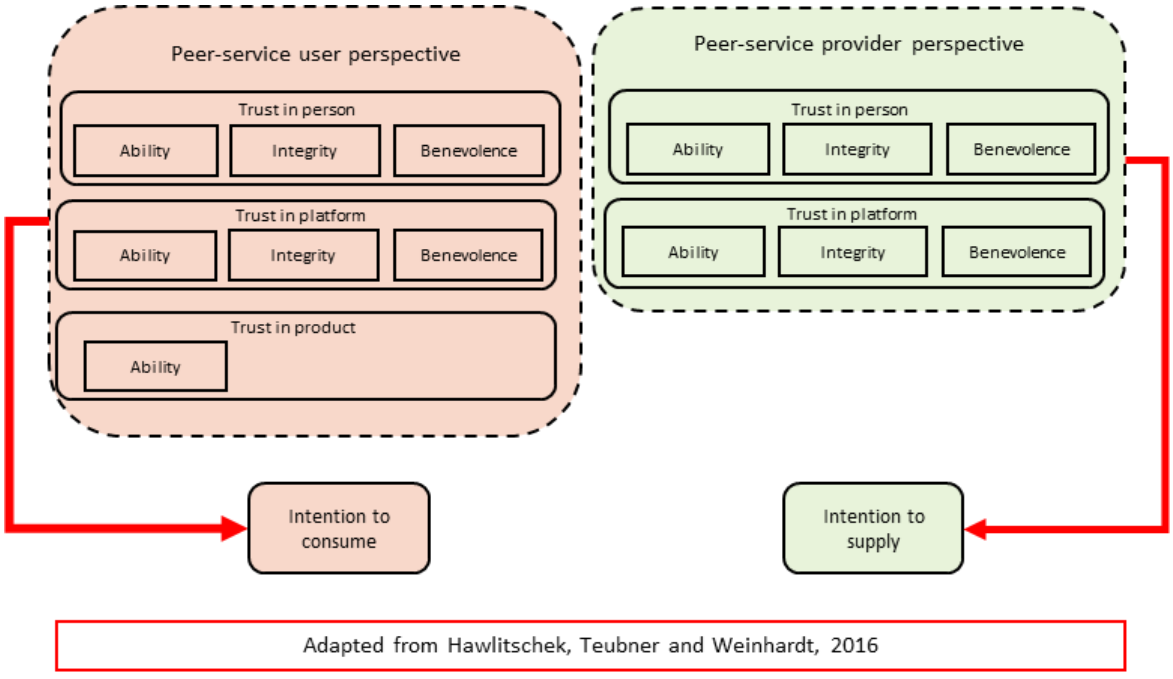

Figure 4: The conceptual framework of trust in the sharing economy.

The rest of this section will review the current literature exploring trust in the context of P2P mobility innovations.

2.3. Trust in the context of P2P mobility

Trust in the context of P2P mobility is a comparatively understudied field of the sharing economy literature. Despite this, both P2P ride sharing and P2P car sharing require trust. In P2P ride sharing, adopters share a journey together in the setting of one party's personal car. For P2P car sharers, peer-providers are trusting peer-users (who are usually strangers) with their personal vehicle.

In the context of P2P ride sharing, trust in other users takes on different meanings for peer-providers and peer-users. Peer-providers are often in the position of power, as they can control the journey logistics and who they allow to be a peer-user (Ma and Hanrahan, 2020). While it could be argued that both peer-users and peer-providers are trusting the other party with their personal safety, the peer-user is trusting the peer-provider to get them to their destination safely. This further reinforces the potential power imbalance between the two peer-roles.

Amirkiaee and Evangelopoulos (2018) find that trust is a strong predictor of people's intention to travel by ride sharing. They did not look specifically at P2P ride sharing, but instead defined ride sharing to include "traditional and IT enabled ride sharing" (p13), including private vehicles, ride sharing clubs, ride hailing companies (e.g., Uber and Lyft, in certain circumstances where it is conducted non-professionally and on an ad-hoc basis). They suggest that platforms should facilitate trust-building between adopters through reviews, rating systems, and background checks to encourage more widespread adoption. However, the authors do not explore the impacts or effectiveness of the proposed trust-building mechanisms. Furthermore, they propose that ride sharing which occurs in an existing social-network system, for example a university, workplace, or affiliation with a specific community, occurs within an environment of trust. Chaube *et al*. (2010) also find trust to be a main barrier to the adoption of P2P ride sharing for both peer-providers and peer-users. They similarly suggest that "communities based on common social networks" (p1) could alleviate some of the trust concerns and aid the diffusion of P2P ride sharing. This mechanism of building trust through sharing within "communities" is explored further by Ma and Hanrahan (2020). People who travel by P2P ride sharing together have a shared common goal and typically common backgrounds, and it was found that this helps build trust between peers. Interestingly, the authors found that this framing of a common goal leading to increased trust was applicable both for commuters (who typically ride share with the same group of people repeatedly), and one-off users.

However, in their study of adopters' perceptions of trust in various groups of people, Mazzella *et al*. (2016) found that adopters of BlaBlaCar trusted other users of the platform with full digital profiles almost as much as they trust their friends and family. In contrast with some of the previously reviewed literature which proposed that social networks and belonging to the same community were important factors in predicting trust, adopters of BlaBlaCar trust their colleagues, neighbours, and social media contacts significantly less than they do other users of the platform who have full profiles. This result supports the authors' hypothesis that digital platforms can facilitate trust between strangers. Furthermore, this could be regarded as an example of "community-building" among BlaBlaCar users.

Arteaga-Sanchez *et al*. (2018) explore the motivations of current P2P ride sharing adopters in Spain to continue using P2P ride sharing (specifically BlaBlaCar). They similarly find that trust is the strongest determinant factor predicting an adopter's satisfaction of using BlaBlaCar. In turn, an adopter's satisfaction of using BlaBlaCar is the strongest determinant factor predicting an adopter's intention to continue using BlaBlaCar. The authors conclude that it is vital to "adequately manage" the community of adopters of P2P ride sharing platforms, in order to "create a trustworthy environment that will satisfy their users" (p21). In other words, they suggest that the platform should facilitate trust-building between its user base, and this would have positive effects on adopters' satisfaction and intentions to continue using P2P ride sharing. However, it is important to note that the authors do not distinguish between the different types of P2P adopter (peer-providers and peer-users). They highlight this as a limitation of their study and call for future research to analyse potential differences between the distinct adopter groups.

Most of the literature on trust in the context of P2P mobility takes other users (or peers) as the target of trust. There is an identified lack of research into trust in the platform. One notable exception is Mattia *et al*. (2021). They investigate potential P2P ride sharing adopters' intentions to adopt the innovation in Italian cities. The authors explore trust in the platform as a possible determinant of intention to adopt, arguing that trust in the platform is a neglected target of trust in the literature. They regard trust and the platform in two ways. First, they frame trust as being platform-mediated in the context of the sharing economy (Mohlmann, 2016), and therefore the platforms build a pivotal role in building trust among users. Second, they propose that trust in the platform itself is vital. Trust in the platform refers in part to the security of the platform, the reputation of the platform, the "commitment to serve customers at the highest standards", and the platforms demonstration of business competence (ter Huurne *et al*., 2017, p2). They find that trust in

the platform is most important in determining a non-adopter's propensity to adopt P2P ride sharing. This supports the suggestion by Mohlmann (2016) that trust in platform mediates trust in other users.

In the context of P2P car sharing, peer-providers are trusting potential strangers with a high value and symbolic item – their personal car (Julsrud and Uteng, 2021). Perhaps for this reason (and in contrast to other innovations using sharing economy business models), most research into the role of trust in P2P car sharing has been centred on the peer-providers' perspective. Valor (2020) explores the anticipated emotions towards P2P car sharing from the perspectives of both potential peer-users and potential peer-providers (i.e., current non-adopters) in Spain. She finds that both groups anticipate feelings of stress, anxiety, and fear if they join a P2P car sharing scheme. For potential peer-providers, the anticipated burden of sharing their vehicle is in part due to "emotional" barriers to adoption, and not wanting to share their private and personal safe space. Furthermore, the author finds that the presence of reputational mechanisms such as reviews and ratings is not enough to encourage potential peer-providers to join a P2P car sharing platform. The digital mechanisms for building trust between users are not strong enough to overcome the perceived risks.

While the literature reviewed so far explores the importance of trust in other users in the continued adoption of P2P mobility, there are few studies which investigate specifically the mechanisms of building and maintaining interpersonal trust, beyond platform-facilitated mechanisms. Shaheen *et al*. (2012) investigate trust in different P2P mobility innovations and propose that face-to-face contact is important in building trust between users. However, adopters often must form an opinion of a potential match's trustworthiness before meeting them in person. Zhou *et al*. (2017) find that sharing social media profiles (specifically Instagram) with other users before meeting to ride share positively influences perceptions of trust in the other user. They propose that sharing social media profiles provides evidence of social proof, social approval, and self-disclosure, all of which influence trust-building between peers. While this could help build trust between adopters of P2P ride sharing before they meet in person to complete a trip together, some P2P car sharing platforms operate "key-less" systems, meaning that peer-providers and peer-users never meet in person. Svangren *et al*. (2019) found that some peer-providers chose to leave personal items in their cars, to ensure a more personal experience and to remind the peer-user that they were borrowing someone's private car. For some peer-providers, leaving small personal items in the car was viewed as a mechanism to hopefully prevent damage to their vehicle. The authors framed this finding as an "alternative coping strategy" (p13), in addition to the

online trust mechanisms (including ratings and reviews) to alleviate concerns about the potential risks associated with P2P car sharing.

Münzel *et al*. (2020) explore the adoption of P2P car sharing in German cities and find that people who are already sharing their personal car on an informal basis to family and friends are more likely to join a P2P car sharing platform as a peer-provider. They propose that people who already lend their car to others have a diminished personal attachment to their private car, enabling them to consider listing their car on a P2P car sharing platform. Diminished emotional attachment to their private car and prior experience of trusting others with their car (albeit people from within their personal social network) are essential for potential adopters to be able to overcome the perceived risks. In contrast with Valor (2020), the authors propose that online ratings and review systems can help increase trust and reassure potential peer-providers. However, unlike the study by Valor, this speculation was not supported by data. Julsrud and Uteng (2021) compare different types of trust (inward, outward, and technology-based) among adopters of different business models of car sharing (P2P, cooperative, and B2C). They find that technology-based trust is the most important type of trust to P2P car sharing adopters. As P2P car sharers do not typically share with the same person(s) repeatedly, the authors find that building and maintaining strong interpersonal trust is less important for P2P car sharers than it is for cooperative car sharers. Instead, technology-based trust systems, specifically trust in online reputation systems, trust in "social identity markers", and transparent insurance systems are most important. The authors conclude that online reputation systems are crucial for building trust on P2P car sharing platforms. This finding supports those by Münzel *et al*. (2020).

Reviewing the literature on trust in the context of P2P mobility using the framework proposed by Hawlitschek, Teubner, and Weinhardt (2016), numerous research gaps become apparent. While both trust in other users and trust in the platform itself have been recognised as important targets of trust, there is much less empirical research into how trust in the platform is built and maintained. Indeed, most literature exploring trust in the platform regards the platform as a mechanism of facilitating trust among peers, and not as an entity requiring trust in itself. Furthermore, there are no known studies in the P2P mobility context which explore adopters' perceptions of trust in the product. Furthermore, there is a lack of research into how different adopter groups (peer-users and peer-providers, and adopters of P2P car sharing and P2P ride sharing) compare in their perceptions of and requirements for trust. Typically, current literature either focusses specifically on one adopter group, or combines adopters of different peer-roles into one group, assuming

homogeneity. In addition, there are no known studies of trust in P2P mobility which distinguish between the three main dimensions of trust: ability, benevolence, and integrity. Finally, there are no known studies which investigate the role of trust in product in the context of P2P mobility. This is surprising, given the safety implications of travelling by car.

2.4. Emissions impacts of P2P mobility

Both P2P ride sharing and P2P car sharing capitalise the idle capacity associated with private vehicle ownership. It is estimated that private cars in the UK are parked 95% of the time (RAC Foundation, 2021). Both P2P ride sharing and P2P car sharing rely on changing adopter practices to increase the utilisation rates of existing private vehicles (Svennevik, 2019). Both innovations offer the potential to reduce private car ownership and the associated environmental impacts through increasing the frequency of use and occupancy rates of existing cars. However, it is important to highlight that, in contrast to other sustainable mobility innovations which aim to replace the private car, e.g., B2C car clubs (see Martin *et al*., 2010; Jain *et al*., 2021), Mobility-as-a-Service (see Kamargianni *et al*., 2018), and ride hailing (Tirachini, 2020; Clelow and Mishra, 2017), the business model of P2P mobility is dependent on private car ownership. Therefore, the potential impacts on emissions do not arise solely from forgone vehicle purchases, but an interaction of effects.

Estimating the GHG impacts of P2P mobility is complex and there are numerous effects which can be explored. The adoption of P2P mobility can have sustainability impacts in the following ways: through sold vehicles (the shedding effect), foregone vehicle purchases (the suppression effect), increased multimodality (the substitution effect), reduced vehicle kilometres travelled (VKT), reduced fuel consumption, and greater overall environmental awareness (Shaheen *et al*., 2019).

In their 2017 briefing, Bondorova and Archer review the evidence for the relationship between car sharing and car use. Ultimately, they find that the "overwhelming majority" of the evidence shows that car sharing and ride sharing schemes across different business models do offer the potential of a net reduction in car use. However, they focus solely on the behaviour change effects of car sharing and ride sharing in terms of the substitution effect, and do not draw upon any evidence from different emissions reductions mechanisms, for example the shedding or suppression effects. Gossen *et al*. (2019) propose that there are three aspects which determine whether P2P activities can have a positive environmental impact. First, whether the use of P2P impacts the production of new goods (in this case new cars); second, whether the use of P2P increases resource use during transactions; and third,

whether the use of P2P leads to direct or indirect changes in consumption behaviours (including rebound effects). However, these generalisations are not specific to P2P mobility.

The rest of this section will review the current literature exploring the emissions impacts of P2P mobility innovations.

2.4.1. P2P car sharing

There is only one known study which quantifies the emissions impacts of P2P car sharing without drawing a direct comparison with B2C car sharing. Gossen *et al*. (2019) explore the proposed mechanisms through which P2P car sharing is thought to provide sustainability benefits, and they review empirical evidence for the causal mechanisms therein. They review a German-language publication by Henseling (2018) which estimates that about 10% of the German adult population will adopt P2P car sharing, and this will be the full market saturation. They calculate emissions reductions savings of 2.7 million tons CO_2; however, 1.1 million tons will be negated by increasing car use instead of alternative modes of transport (a rebound effect), resulting in a net emission reduction of approximately 1.6 million tons CO_2 annually. However, the original research paper is only available in German, so it is difficult to understand the exact assumptions and specific details of which effects are included in these estimates. Furthermore, it is not known how the authors arrived at their estimate that P2P car sharing will reach market saturation (in other words the diffusion potential) at 10% of the total population.

With the exception of the paper by Henseling (2018) reviewed above, there are no current publications exploring the emissions impacts of P2P car sharing exclusively. In their 2020 paper quantifying emissions impacts of B2C car sharing through LCA, Amatuni *et al*., state that they "focus only on the B2C platforms as the impacts of peer-to-peer car sharing platforms on travel behaviour have yet to be statistically quantified" (. However, there are some published studies exploring the effects of car sharing, without keeping the distinction between P2P and B2C business models. These are reviewed below.

Arbeláez Vélez and Plepys (2021) compared the emissions impacts of B2C and P2P car sharing fleets and found that B2C car sharing had an emissions reduction potential that was 5% higher than P2P car sharing. This observed difference is because "B2C fleets are more fuel efficient and have a higher percentage of low- or zero-emissions vehicles" (p2). The authors assumed that use behaviour would be constant between adopters of the two groups, and the sole differences between B2C and P2P car sharing arises from the fleet composition, leading to different vehicle emissions factors. Furthermore, the authors only considered

direct effects, and did not consider the impacts of embodied emissions in vehicle production, maintenance, and end-of-life processes.

In contrast, Nijland and van Meerkerk (2017) explore the emissions impacts of car sharing in the Netherlands and do quantify the impacts of changing use behaviours, among other effects. The authors find that car sharing causes emissions reductions of 236 to 392 kg CO_2e per person annually. This reduction is attributed to adopters driving fewer kilometres (behaviour change), reduction in levels of car ownership (the shedding effect), and the reduced need to purchase a second or third car (the suppression effect). However, the data used to derive these estimates does not focus exclusively on P2P car sharers. P2P car sharers comprised 20% of their survey sample; the sample of B2C and P2P adopters were treated as one group. The authors recognise this as a limitation of their research and call for further research to explore the potential differences between different car sharing business models "… we did not analyse the impacts of each type of car sharer in full detail. However, this is a very interesting field of study, and research in that area would certainly yield new insights" (p89). Furthermore, they focus exclusively on the use-phase emissions, and not the emissions from other life-phases of a vehicle. Although they do include the shedding and the substitution effects (albeit under different names), the lifetime impacts of the shedding and substitution effects are not considered. Finally, the unit of analysis in their study was the average adopter, and therefore differences between different adopter groups (i.e., B2C vs. P2P, regular vs. one-off users) were not considered.

Contrastingly, behaviour change has also been found to increase emissions through rebound effects. Although there are no current studies exploring rebound effects solely in the context of P2P car sharing, Amatuni *et al*. (2020) found evidence of "significant rebound effects" (p8) which reduce the emissions savings potentials of (B2C) car sharing. Specifically, they found that modal shift "moderates the total [emissions] change significantly" (ibid.). They also estimated the life-cycle emissions impacts of using P2P mobility, considering the lifetime shift effects (estimating the impacts that sharing has on a vehicles lifetime in terms of emissions). They estimate an average annual decrease of 823kg CO_2e from reduced private driving, but an average annual increase of 637 kg CO_2e, resulting in an overall reduction of 186 kg CO_2e (for their middle scenario). The authors directly compare their results with Nijand and van Meerkerk's (2017) to estimate the relative contribution of life cycle impacts and rebound effects and find that the emissions reductions potentials they estimate are on average 60% less than the estimates by Nijland and van Meerkerk. They attribute this reduced estimate to the quantified life cycle impacts.

While Nijland and van Meerkerk (2017) do not estimate the life-cycle effects or the lifetime impacts of modal shift, they do find that car-share adopters travel an extra 960km annually in cars that they would not have travelled if they did not have access to a car. This is also an example of a rebound effect, and another instance where the magnitude of the potential emissions impacts of P2P car sharing are dependent on subsequent modal shifts. Similarly, Arbeláez Vélez and Plepys (2021) find that, at the individual level, emissions impacts increase for adopters who did not own private cars before. They estimate that using P2P car sharing instead of a privately owned car reduces annual emissions by 68.68%, however where P2P car sharing is used instead of "car-free travel habits" annual emissions increase by 12.51%. However, at the population level this increase is negated by the emissions impacts of the adopters who use P2P car sharing instead of a privately owned car. The authors conclude that the overall impact on emissions of car sharing depend on the balance between adopters who were previously car owners, and adopters who are not.

The different ways in which P2P and B2C car sharing cars are used could provide a further dimension of difference in the emissions estimates. Münzel *et al*. (2019) find that the typical use of P2P and B2C car sharing is different; peer-users of P2P car sharing tend to borrow a car more infrequently and for longer, one-off "special occasions", whereas users of B2C car sharing regularly borrow a car as part of their routine. They attribute this difference to the different value propositions of P2P and B2C business models and propose that frequent users of car sharing prefer the "more convenient and professional B2C service" (p278) to explain this observed difference. Similar results were found by Julsrud and Farstad (2020), who explored Norwegian households use of different business models of car sharing. They found that P2P car sharers used car sharing significantly less often than B2C car sharers and cooperative car sharers, and through cluster analysis found that most P2P car sharing users fit in the cluster of "long-distance holiday" users. There are similar differences in P2P ride sharing adopter profiles based on different usage characteristics. One-off P2P ride sharing is characteristically used for occasional long-distance journeys (Shaheen *et al*., 2017; Ciari and Axhausen, 2013). The P2P ride sharing platform BlaBlaCar estimates that the average journey distance is 300km (BlaBlaCar, 2017).

The findings from these studies comparing B2C and P2P car sharing adopters and their use characteristics could have implications on the emissions impacts of B2C vs. P2P car sharing. If P2P adopters use car sharing much less frequently than B2C adopters it could be expected that the emissions impacts, arising from the substitution effect may also be reduced.

However, there is no known literature comparing the impacts of P2P and B2C ride sharing considering the suppression and shedding effects.

While the studies discussed thus far have looked at the emissions impacts from the perspective of a peer-user, there is a dearth of research exploring the emissions impacts of P2P car sharing from the perspective of a peer-provider. This could in part be expected, given that most literature exploring P2P car sharing combined P2P and B2C business models. There is no analogous peer-provider in B2C car sharing.

There are numerous studies quantifying the emissions impacts of B2C car sharing which estimate the change in emissions from the suppression effect and the shedding effect (see Shaheen *et al*., 2012; Shaheen *et al*., 2018; Firnkorn and Muller, 2011; Chen and Kockelman, 2016). Kolleck (2021) estimates that every one station-based carshare car (sometimes referred to as two-way car sharing as the car must be returned to the same spot) could replace nine private cars. This reduction stems primarily from the suppression effect (enabling adopters to forgo purchasing an additional private car). However, the author does not find a relationship between free-floating car sharing (also known as one-way car sharing) and car ownership. Kolleck proposes that free-floating car sharing systems are more likely to operate in dense urban areas, where there are much lower levels of private car ownership already. In this situation, P2P car sharing could be regarded as more similar to station-based car sharing, as P2P cars must (typically) be returned to same point as pick-up, and vehicle provision is not restricted to dense urban areas. Contrastingly, Le Vine and Polak (2019) surveyed adopters of free-floating car sharing in London and found evidence of both the suppression and the shedding effect. Specifically, they find that 30% of adopters had decided not to purchase an additional car (the suppression effect), and 4% of adopters had shed a private car in the past three months. While these studies do not consider P2P car sharing and instead focus on B2C adopters, the results could be appropriate in a P2P context as they just consider the peer-user perspective.

There is just one known study estimating the suppression and shedding effects in the context of P2P car sharing. Shaheen, Martin, and Hoffman-Stapleton (2021) surveyed adopters of P2P car sharing in the US and found that 14% of respondents had shed a car since joining a P2P platform, however only 3% of respondents stated that P2P car sharing was the reason why. 44% of respondents stated that if the P2P scheme were to no longer operate, they would purchase an additional car. This is analogous to the suppression effect as it estimates the impacts of forgone vehicle purchases. Interestingly, the authors find roughly the same

percentage as respondents who had got rid of a car had purchased an additional vehicle, for the purpose of renting it on P2P platforms. The purchase of additional vehicles for the sole purpose of renting them on P2P platforms, in effect an "anti-shedding" effect, would further moderate the potential emissions impacts of P2P mobility. There are no known studies which estimate the impacts of these induced effects, as they are specific to P2P car sharing (and not B2C business models). There need to be more adopters (as peer-users) who shed or suppress a car, than adopters (as peer-providers) who purchase and supply additional vehicles for P2P car sharing to have a reduction in emissions.

Reviewing the literature on the emissions impacts of P2P car sharing reveals numerous gaps. The difference in emissions estimates from the different studies discussed in this section arise in part from the range of effects quantified at differing life stages. Amatuni *et al*. (2020) provide the most comprehensive estimate using life-cycle estimates, but solely in the context of B2C car sharing. Furthermore, there are no studies quantifying emissions impacts of P2P or B2C car sharing in the UK. This represents an important gap in the literature.

2.4.2. P2P ride sharing

The adoption of P2P ride sharing can impact emissions in different ways depending on if the adopter is a peer-user or a peer-provider. From a peer-user perspective, using P2P ride sharing can impact emissions primarily through the substitution effect, the suppression effect, and the shedding effect. On the other hand, from a peer-provider perspective, increasing vehicle occupancy rates is the main source of emissions impact. In other words, for peer-providers the emissions change may not come from changes to the vehicle kilometres, but rather from the passenger kilometres as a function of occupancy rate. As well as the direct impacts on emissions from substituting single-occupancy travel with P2P ride sharing, Bondorova and Archer (2017) found that the adoption of ride sharing encourages a behaviour shift to multi-modal, sustainable transport. In this way, the emissions impacts of P2P ride sharing can arise from multiple effects.

Caulfield (2009) used census data to estimate the emissions impacts of P2P ride sharing of commuters in Dublin and calculated the substitution effect of adopters using P2P ride sharing for commuting instead of travelling in single occupancy vehicles. He finds that 12,674 tCO_2 emissions are saved annually in Dublin by commuters who currently commute by P2P ride sharing. However, Caulfield assumes that all commuters who use P2P ride sharing would have otherwise travelled in a single-occupancy car (as a single counterfactual) and does not take into consideration alternative counterfactuals. Furthermore, he does not estimate the

impacts of any other effects, such as the suppression and the shedding effect or any potential rebound effects.

Jacobson and King (2009) modelled the impacts of commuting by P2P ride sharing in the US under different occupancy rate scenarios. However, they find that people's desire to commute by P2P ride sharing is reduced by the need to drive additional distances to collect and drop-off passengers. The authors explored the financial incentives of P2P ride sharing for commuting, and find that adopters value their time more, in monetary terms, than the potential financial savings from commuting with P2P ride sharing. They suggest that the largest emissions decreases can be incentivised through increasing the costs of single occupancy commuting, specifically through increasing parking fees and road toll costs. They estimate that if the cost of commuting was increased by $1 per trip, the number of people commuting by P2P ride sharing would double. The potential fuel savings would be 7.54-7.74 billion gallons (US) per year. Kawaguchi *et al*. (2019) also explore the need to make driving detours to collect and drop off passengers, but they estimate the emissions impacts of these detours. They find that the emissions reductions from P2P ride sharing are reduced by 13% due to the additional driving required to increase occupancy rates.

Minett and Pearce (2011) also explore the emissions impacts of using P2P ride sharing for commuting ("carpooling"). They find that ride sharing leads to a reduction in energy consumption when compared to single occupancy vehicles. The authors also find that P2P ride sharing confers a reduction in energy consumption through the substitution effect when compared to a mix of single-occupancy and public transport (bus). The reduced energy consumption compared to single-occupancy and public transport arise from the "deadhead" emissions of public transport (in this case, the energy used to return an empty bus to the depot), estimated occupancy rates of public transport, and the average speeds of busses vs. ride sharing vehicles. However, it is important to note that the authors do not quantify the impacts in terms of emissions, rather in GJ energy.

On the other hand, Yin *et al*. (2018) find evidence of substantial "rebound effects" when P2P ride sharing is used instead of public transport or active modes of travelling. These rebound effects arise where P2P ride sharing is seen as more attractive than alternatives. As a result, more people choose travelling by car over public transport and active modes for shorter distances, and people travel longer distances by car. In their study, the authors estimate that the rebound effects reduce the potential emissions savings by a third to a half. They propose

that “local authorities should focus ride sharing policies in long distance trips, as the ones with the greatest mitigation potential” (p896).

Coulombel *et al*. (2019) find similar evidence of significant “rebound effects” from the diffusion of P2P ride sharing. They estimate that 68 – 77% of emissions reductions from ride sharing are negated by rebound effects. The largest effect is the modal shift effect, which they describe as adopters choosing to travel by ride sharing instead of public transport in response to the benefits and availability of P2P ride sharing. (However, this could perhaps be better termed a “perverse substitution effect” rather than a rebound effect, in line with terminology used in other literature). The authors note that the magnitude of the modal shift effect is influenced by public transport availability and is expected to be larger in cities with a large public transport modal share.

Most studies explore the emissions impacts of P2P ride sharing being used for commuting, and there are much fewer studies which explore this in the context of infrequent, one-off use. This could be due to the relatively larger potential emissions impacts from making repeated and regular journeys. Furthermore, the shedding and suppression effects are easier to conceptualise and quantify for commuters, where the alternative is usually daily single-occupancy travel. On the other hand, for one-off users, the nature of making one-off, typically longer journeys means that the alternative may not be single occupancy travel. Bondorova and Archer (2017) review a 2017 European Parliament study which explores the impacts of one-off, long-distance P2P ride sharing in France. They find that in this context P2P ride sharing substitutes for long distance public transport. Interestingly, this effect was found for both peer-providers and peer-users. Without the additional financial benefits of P2P ride sharing most peer-providers would have also used public transport for long distance one-off journeys. The emissions impacts of this substitution are dependent on multiple factors, including public transport and ride share occupancy rates, and whether the replaced mode of transport was electrified (e.g., trains).

Tikoudis *et al*. (2021) explore the emissions impacts of ride sharing in different contexts in 247 cities, through a discrete choice econometric model. They find that, on average, the adoption of ride sharing could reduce emissions by 6% in 2050 compared to the reference scenario. In the reference scenario there is assumed to be no change to the barriers of ride sharing adoption. In what they term the counterfactual scenario (i.e., the high ride sharing scenario), it is assumed that “regulations that currently hamper operators from entering the market are removed … and technological progress renders these services more efficient”

(p11). The authors find that the greatest emissions reductions from the adoption of ride sharing come from cities with specific characteristics (compact with limited sprawl). On the other hand, the adoption of ride sharing in cities with very high public transport occupancy rates is expected to increase emissions, through lowering public transport occupancy rates and thus increasing their emissions factors. Cities which have high urban sprawl and high levels of car dependency are expected to have the lowest emissions reductions. It is important to note that the authors do not use a definition of ride sharing which explicitly mentions "peer-to-peer". Instead, the authors define "ride sharing" as "any mobility service that: (i) has the capacity to simultaneously serve at least two passengers with different pick-up and drop-off locations, and (ii) uses an on-demand algorithm to match passengers served in the same ride" (p2). Although they do not provide further examples or specificity of what this definition includes, it could be assumed that this does include "ride splitting" (sometimes referred to as "shared ride-hailing" services). Despite this potential difference, the findings that P2P ride sharing offers the highest emissions reductions when it is not substituting for public transport use have been supported by various other studies (including Yin *et al*. (2018) as outlined above).

While numerous studies find that P2P ride sharing could reduce the need for an individual to buy a car (i.e., the suppression effect) (see Bondorova and Archer, 2017; Shaheen *et al*., 2018; Herzog *et al*., 2006), there are few studies which explore the emissions impacts of the suppression and shedding effects in the context of P2P ride sharing. Carroll *et al*. (2017) conducted a stated-preferences survey and estimate that, as a best-case scenario, 8% of car owners would "shed" their vehicle if there were greater support for commuting by ride sharing. The authors do not explore the potential emissions impacts of this shedding effect but do highlight this as an important area for further research, "Further examination of the potential for car-shedding behaviour is also planned utilising more complex national demand forecast models to establish precise modal share predictions and to produce estimates for the associated impacts on emissions levels" (p451).

Laakso (2017) designed an experiment exploring the emissions impacts of the shedding effect over a six-month period with 11 households in Finland, by monitoring their subsequent travel use. They found that the average household travel emissions were reduced by 43%, with the range from 8% - 69% reduction. Interestingly, some households that participated in the study owned multiple cars. Shedding one car still "forced the participants to adjust their everyday living on the prerequisite of not having a car available all the time" (p135), and still found significant reductions in the number of kilometres driven (by an average of

110km per person per week). Although the shedding effect here was not stimulated by the adoption of P2P ride sharing, the impacts of the shedding effect quantified here could be transferable.

This chapter has reviewed the existing literature on the adoption, use, and emissions impacts of P2P car sharing and P2P ride sharing. The next chapter will reiterate the key knowledge gaps identified in this literature review, present the research aim and questions for this thesis, and present an overview of the structure of the empirical research chapters.

Chapter 3: Research design

3.1. Research aims and questions

In view of the literature reviewed in chapter 2, and the context provided in chapter 1, several key gaps in the literature surrounding the adoption and emissions impacts of P2P mobility innovations are apparent. Research into mobility innovations in the "sharing economy" tends to either focus exclusively on B2C business models or to conflate P2P and B2C business models. P2P mobility remains comparatively understudied.

DOI identifies the importance of early adopters and characterises them as an ideal type. However, there is a recognised lack of consensus in the literature about the characteristics of early adopters of P2P mobility. To understand why early adopters participate in P2P mobility innovations it is necessary to understand how they perceive the attributes offered by these business models. Furthermore, most of the reviewed literature is based on research from continental Europe or America. Understanding who the early adopters of P2P mobility are in the specific context of the UK represents a critical knowledge gap. Most previous research either treated both peer-provider and peer-users of P2P mobility as one homogenous group or focussed specifically on just one of these two peer-roles. This project will explore the diversity among adopters of the same innovation.

While trust has been recognised as one of (and in some cases *the*) most important barriers to adoption of P2P mobility, previous research has typically focussed on trust in other users of P2P platforms. There are no known studies which use the dimensions and targets of trust framework considering both peer-users and peer-providers perspectives in the context of P2P mobility. It is important to understand the unique perspectives of both peer-roles.

Numerous authors cite the potential environmental benefits of P2P mobility however these claims are often "idealized" and reveal "potential extreme positive outcomes" rather than a behaviourally realistic approach (Axsen and Sovacool, 2019, p2). There are few studies which quantify these potential benefits in terms of emissions reductions. The literature into the emissions impacts of P2P mobility innovations draws vastly different conclusions, in part based on differences in the effects and the scale at which the impacts are estimated. Furthermore, estimations into the emissions impacts tend to focus on the "typical" adopter, and the diversity of adopters with different characteristics, use behaviours, and motivations are not taken into consideration.

This thesis aims to address these gaps in the literature; the research aim of this thesis is ***to explore the adoption and diffusion of P2P mobility innovations and to assess the potential impacts on emissions***. To address this aim, three research questions are developed:

1. Who uses P2P mobility innovations and why do they do so? (Chapter 4)
2. What is the role of trust in the adoption of P2P mobility innovations? (Chapter 5)
3. What impacts could the adoption of P2P mobility have on emissions? (Chapter 6)

The research questions will be addressed using a comparative research strategy. Comparative research strategies compare two or more cases using similar (or identical) methods (Bryman, 2016). Bryman (2016) describes a comparative research strategy as "…essentially two or more cross-sectional studies carried out at more or less the same point in time" (p74). The two innovations which will be used as case studies are P2P car sharing and P2P ride sharing. The selection and justification of these two innovations is presented in the following section.

3.2. Justification of selected P2P schemes

This thesis uses P2P car sharing and P2P ride sharing as two case studies of P2P mobility innovations. By comparing the adopters, their motivations, and the contextual settings in which these innovations are used, it will be possible to build a more informed picture of the diffusion potential of these innovations. Furthermore, understanding the diffusion potential and the external factors which shape this is vital to estimate the emissions impacts that P2P mobility currently have and could have under different future scenarios. Using both of these innovations as examples of P2P mobility innovations allows for a deeper exploration of the diversity of P2P mobility innovations.

P2P ride sharing, and P2P car sharing were selected as case studies of P2P mobility innovations for various reasons. Both P2P ride sharing and P2P car sharing are capitalising on the idle capacity associated with private vehicle ownership. P2P car sharing and P2P ride sharing "decouple" ownership and private use of cars, albeit through different business models. However, in contrast to other sustainable mobility innovations (for example multi-modality, active modes of transport, and B2C bike/e-bike/e-scooter sharing) P2P car sharing and P2P ride sharing provide the benefits of travelling by car and do not aim to fully replace private car ownership. Instead, the sustainability benefits stem from changing uses of private vehicles.

Studies assessing the adoption of B2C mobility innovations (most notably B2C car sharing) have found that these are more successful in densely populated urban areas (see Jie *et al.*, 2020). This is due to the need for a critical mass of users to make B2C car sharing profitable (Münzel *et al.*, 2019). However, it has been suggested that the need for a critical mass of

users in urban areas is reduced for P2P car sharing. P2P car sharing occurs in semi-urban and rural areas as well as urban areas. This difference can be explained by the spatial heterogeneity of car ownership. Rural populations are more likely to own cars than urban populations (Dargay, 2002). The supply of P2P car sharing vehicles can occur anywhere a car owner lives and is not limited to urban areas (Meelen *et al*., 2019).

Furthermore, P2P car sharing and P2P ride sharing are two examples of sustainable mobility innovations which are not dependent on technological advances, and instead are "innovative" due to the P2P business models offering potentially new mobility practices using existing vehicles. Innovative behaviours, practices, and cultural models, and markets and business models have been proposed as non-technical dimensions of disruption (Kivimaa *et al*., 2021), with the potential to accelerate sustainability transitions.

Despite these similarities, car sharing and ride sharing vary in critical ways. P2P car sharing is a product-service system, in that it combines access to an asset (the vehicle) and the vehicle is used to provide the service of mobility. On the other hand, P2P ride sharing is generally regarded as a service-system, as consumers do not get rival access to the asset (the vehicle) and are instead receiving the service of mobility.

These different business models frame a key difference between P2P car sharing and P2P ride sharing - a different emphasis is *what* is being shared. From a peer-provider perspective, P2P car sharers grant temporary access of their entire vehicle to others. The peer-provider does not have access to their vehicle during the rental. Furthermore, some platforms operate with "keyless" technologies so there is no need for the peer-provider and the peer-user to ever meet. In contrast, P2P ride sharers grant temporary access to a passenger seat in their vehicle during a specified journey. The peer-provider is always driving their own vehicle and shares the journey in the company of others.

P2P ride sharing is inherently more 'social' than P2P car sharing, as it requires individuals to share a journey. These individuals may know each other previously (in the case of workplace-based schemes) or belong to the same extended social networks (in the case of community based or local schemes), however they may also be strangers with no social connections (in the case of many platform-based schemes). For these reasons, some authors consider P2P ride sharing as a 'social event' (Chaube, Kavanaugh and Perez – Quinones, 2010). It has been suggested that those who enjoy being more social are more likely to have a more positive attitude of P2P ride sharing (Amirkiaee and Evangelopoulos, 2018). In contrast, P2P car sharing enables peer-user's relative freedom and distinguishes a clear 'boundary between

self and others' (Bardhi and Eckhardt, 2012), and peer-users value the "individual" nature of car sharing as a means of mobility (Kopp, Gerike, and Axhausen, 2015).

The ownership of a personal vehicle is associated with instrumental, hedonic, and symbolic attributes (Schuitema *et al*., 2013), and is often an expression of one's personal identity. Granting temporary access of your personal car to a *de facto* stranger is at the extreme end of a system of trust (Mohlmann and Geissinger, 2018). For this reason, P2P car sharing is an extreme example of a physical asset which a consumer can grant others temporary access to; if you can share your car, you can share anything.

While the service received by peer-users of P2P and B2C car sharing platforms are similar, peer-users of P2P car sharing have been found to value the status associated with renting certain cars. Having the choice of the specific make and model of car, and the symbolism attached to that car, appeals to "status-conscious" peer-users (Wilhelms, Merfeld, and Henkel, 2017).

To summarise, P2P ride sharing and P2P car sharing were selected for this study as they are both P2P mobility innovations which harness idle capacity from private cars as a potential pathway to more sustainable, yet still car-based, mobility practices. However, these innovations differ in critical ways, and these differences stem from the different business models of these two innovations. P2P car sharing and P2P ride sharing therefore tell different aspects of the story of P2P mobility. Using these two innovations as case studies draws out insights into P2P mobility which would not have been apparent from looking at just one innovation.

3.3. Structure of empirical research chapters

This thesis uses different methods and frameworks in each of the empirical chapters. Each empirical chapter contains a specific introduction, methods, results and analysis, and discussion section. For this reason, the specific methodologies used to address each research question of this thesis are presented in the specific empirical chapters.

Chapter 4 investigates the early adopters of P2P mobility using elements of DOI as a framework. This question is addressed through in-depth survey with adopters of P2P car sharing, adopters of P2P ride sharing, and non-adopters and subsequent quantitative analyses. Chapter 5 explores the role of trust in the adoption of P2P mobility innovations. Focus groups were conducted with different adopter groups identified in the previous empirical chapter. These focus groups were designed using the dimensions and targets of

trust framework by Hawlitschek, Teubner, and Weinhardt (2016) and were analysed using content analysis. Chapter 6 examines the potential emissions impacts of P2P mobility. This chapter takes a three-step approach: first, the current impacts of P2P mobility adoption at the individual level are estimated. Second, these estimates are scaled up to the behaviourally realistic and the technical full potential population, based on insights from the previous research chapters. Third, a series of future scenarios are developed using the 2x2 matrix technique, to explore the impacts that trust (as identified as being pivotal in chapter 5) and institutional support (as emerging as being important in chapter 5 and in secondary research into P2P mobility in the context of the UK) have on the potential uptake of P2P mobility innovations and the associated emissions impacts. The outline and structure of the empirical research chapters are presented in Figure 5.

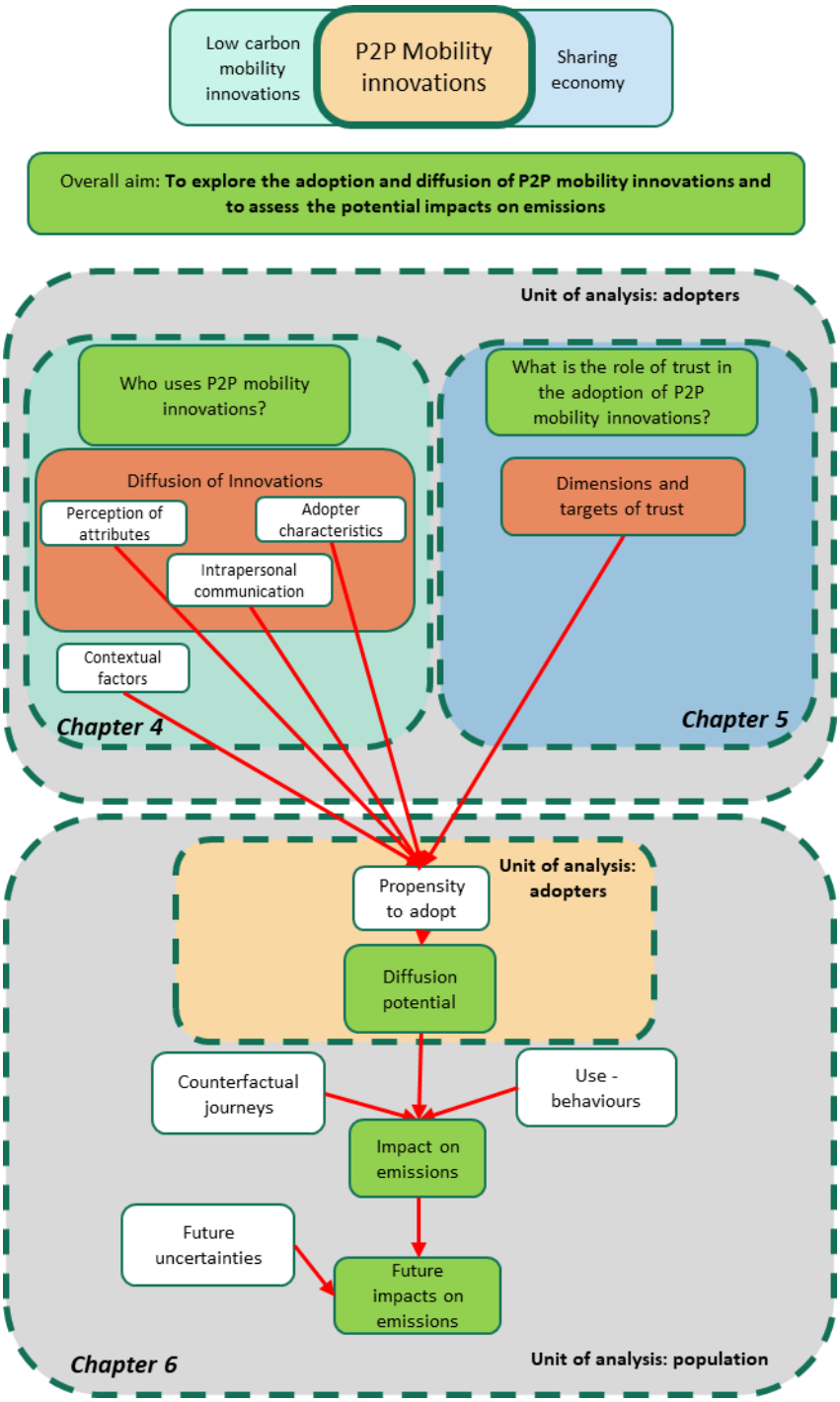

Figure 5: Outline and structure of empirical research presented in this thesis.

Chapter 4: Characterising the adopters of P2P mobility innovations

4.1. Introduction and rationale

This chapter addresses the question "***who uses P2P mobility innovations?***". There are currently few studies which explore the adoption of P2P mobility innovations using Diffusion of Innovations theory (DOI) as a framework. Despite this, DOI provides an appropriate and insightful framing for this research question. Specifically, DOI informs expectations about the personality and socio-economic characteristics of adopters, the perceptions of key attributes (namely the relative advantage, complexity, compatibility, trialability, and observability), and the roles of trusted information sources and social influence in the adoption of innovations. These three elements of DOI will be used in this chapter to explore and frame this research question.

The aim of this chapter is to explore who the adopters of P2P mobility innovations are, and to understand what attributes of P2P mobility innovations they find appealing. In the literature, early adopters are often treated as one homogenous group, sharing similar characteristics, and attracted to similar attributes. Through this in-depth exploration of early adopters as peer service users and peer service providers the diversity among early adopters of the same innovation shall aim to fill this current knowledge gap. Furthermore, this chapter seeks to understand to what extent adopters of P2P mobility innovations can be characterised by DOI.

This chapter addresses two sub-questions:

1. Who uses P2P mobility innovations?
2. How do adopters perceive the attributes of P2P mobility innovations?

Both sub-questions contribute to the overall understanding of the heterogeneity of adopters, and their different drivers to adopt P2P mobility innovations. Furthermore, exploring these different dimensions of diversity among adopters will provide important insights for the next two empirical chapters.

4.2. Hypotheses

Both P2P car sharing and P2P ride sharing are explored as case studies to address this research question. By using these two examples of P2P mobility innovations it is possible to test the sensitivity of the two sub questions to the innovation characteristics and adoption conditions.

The hypotheses developed in this chapter are tested using a "wide comparison" approach (i.e., testing for differences between adopters of P2P mobility innovations and non-adopters)

and using a "deep comparison" approach (i.e., testing for differences between the three samples of P2P ride sharers, P2P car sharers, and non-adopters). The hypotheses and how they relate to the literature are introduced next. This section concludes with Table 1, which summarises which hypotheses are tested using which approach (wide comparison or deep comparison) and presents the justification for these decisions.

4.2.1. Who uses P2P mobility innovations?

DOI is useful for providing generalisations about the types of people who may adopt innovations in general. However, there is a tendency in early adopter literature to treat early adopters as a homogenous group who share similar characteristics (Lee *et al*., 2019). P2P innovations are dependent on adopters performing different, complementary peer-roles to complete a transaction. Different peer-roles (i.e. peer-provider and peer-user) have different circumstances, motivations, needs, and expectations.

Furthermore, mobility choices are context dependent. A person's mobility options are determined by location (e.g., higher dependency on cars in rural areas) (Clark and Finley, 2010), whether someone has a driving license, household compositions, and life stage (Clark *et al.,* 2016), access to a car, among others. ***Therefore, it is expected that there are different types of P2P mobility adopters and these differences are shaped by different contextual factors.***

Studies have found that both providers and users of P2P car sharing and P2P ride sharing cite potential financial benefits as a motivation for participating in shared mobility innovations (see Wilhelms *et al*., 2017; Shaheen, Mallery and Kingsley, 2012; Amirkiaee and Evangelopoulos, 2018). However, these financial benefits take different forms; peer-users potentially save money, whereas peer-providers potentially earn money. Related to this is the variable of car ownership. There is an established relationship between income level and private vehicle ownership (Fox *et al*., 2017). Both P2P ride sharing and P2P car sharing require providers to have a private car that they are then able to offer to users. Given this, ***it is expected that adopters of P2P car sharing have higher incomes and own more private vehicles than do adopters of P2P ride sharing.***

It has been suggested that the kinds of people who participate in the sharing economy are more social by nature (Malecka *et al*., 2022). Therefore, ***it is expected that adopters of P2P mobility innovations are more sociable than non-adopters***. However, there may also be differences between adopters of the two innovations. P2P ride sharing is inherently more 'social' than P2P car sharing, as it requires individuals, who may not previously know each

other, to share a journey in one of the parties' personal vehicles. Amirkiaee and Evangelopoulos (2018) developed a series of hypotheses relating selected personality and contextual factors to people's attitudes towards P2P ride sharing. They expect that people who gain more enjoyment from being social are more likely to regard P2P ride sharing positively. Other authors consider P2P ride sharing as a 'social event' (Chaube, Kavanaugh and Perez – Quinones, 2010). In contrast, P2P car sharing allows users to have sole, rival access to a vehicle. This difference in the social aspect of these two P2P mobility innovations could appeal to different early adopter groups. Therefore, ***it is expected that adopters of P2P ride sharing have a higher level of enjoyment of being social than adopters of P2P car sharing.***

Both P2P ride sharing and P2P car sharing require adopters to use mediating digital platforms. The dependence of these business models on information and communication technologies (ICT) can be a barrier to the adoption of these innovations and requires adopters to have a certain level of capability and familiarity using ICT. Sharing economy platforms have been described as "ICT-enabled" (Curtis and Lehner, 2019). *Therefore**, it is expected that adopters of P2P car sharing and P2P ride sharing are more technophilic than non-adopters***.

DOI proposes that diffusion is a social process and is shaped by the flow of information through a social network (Rogers, 2003). Social influence mechanisms are key for spreading information among a social network and can facilitate the diffusion of an innovation (Vrain *et al*., 2022). Trusted information sources play an important role in the knowledge phase of the innovation-decision process and can ultimately affect a person's decision to adopt an innovation or not. For these reasons, ***it is expected that adopters of P2P car sharing and adopters of P2P ride sharing place greater importance on their social networks as trusted information sources than do non-adopters.***

Considering trust from a different perspective, the concept of trust has been identified as one of the most important long-term drivers of success of peer-to-peer platforms (Cook and State, 2015). Trust is a vital component of the sharing economy (Hawlitschek, Teubner, and Weinhardt, 2016), and lack of trust has been identified as a barrier to the adoption of P2P mobility innovations (Amirkiaee and Evangelopoulos, 2018). Participating in both P2P ride sharing and P2P car sharing requires the adopter to be trusting of both the mediating platform (as a "mediator" as well as an information source), and the other users of that platform. In this way, trust is vital to the continued adoption of an innovation. Therefore, ***it***

is expected that both adopters of P2P car sharing and adopters of P2P ride sharing have higher levels of trust than do non-adopters.

DOI describes diffusion as a social process. Central to this process is the role of opinion leaders (as early adopters), who have the greatest influence within their social networks to share trusted knowledge and information of new products and services (Cho *et al.,* 2011). Therefore, ***it is expected that adopters of P2P mobility innovations are more likely to perceive themselves as opinion leaders than are non-adopters***.

4.2.2. How do adopters perceive the attributes of P2P mobility innovations?

The purpose of this sub-question is to identify why adopters use P2P mobility instead of alternatives. Rogers's Diffusion of Innovations theory identifies five key attributes which can be used to explain the adoption of an innovation, namely:

1. The **relative advantage** it offers compared to the existing practice with which it competes
2. **Compatibility** - the degree to which an innovation aligns with a potential adopters existing personal values, past experiences, and needs
3. **Complexity -** the degree to which an innovation is perceived as being difficult to understand or use
4. **Trialability** - the degree to which an innovation can be tested on a limited basis prior to adoption
5. **Observability** - the degree to which the results of an innovation are visible to others

The way an individual perceives these attributes can predict the rate of adoption of an innovation (Rogers, 2003). There is a positive correlation between how an individual perceives the relative advantage, the compatibility, the trialability, and the observability of an innovation and their propensity to adopt it. Conversely, there is a negative correlation between how an individual perceives the complexity of an innovation and their propensity for adoption. Therefore, understanding how adopters perceive the attributes of P2P mobility, and how these compare to non-adopters' perceptions is important as it provides a basis for understanding the diffusion potential of P2P mobility innovations.

Therefore, it is expected that adopters of P2P mobility are significantly more likely to perceive the relative advantage, compatibility, trialability, and observability of P2P mobility innovations positively than are non-adopters. On the other hand, it is expected that adopters are significantly less likely to regard P2P mobility as complex than are non-adopters.

A summary of the hypotheses and where the expected differences lie is presented in Table 1.

Table 1: The variables, comparison approach, and justifications for the hypotheses explored in this chapter.

Hypothesis (SQ1 = sub-question 1) (SQ2 = sub-question 2)	Variables to be tested	Wide comparison approach (Adopters vs. non-adopters)	Deep comparison approach (Ride sharing adopters vs. car sharing adopters vs. non-adopters)	Justification for testing between group or within group
Contextual factors cause different types of P2P mobility adopter (SQ1)	Age, income, gender, education, employment		✓	All three variations of the survey included an identical question block asking for the sociodemographics of respondents. Therefore, it is possible to use the dataset to statistically compare between groups (adopters of P2P mobility and non-adopters) and within groups (adopters of P2P ride sharing and adopters of P2P car sharing).
Adopters of P2P car sharing have higher incomes and own more private vehicles than adopters of P2P ride sharing (SQ1)	Household car ownership, financial situation, income		✓	These survey items were included in the sociodemographic question block as described above.
Adopters of P2P ride sharing enjoy being social more than adopters of P2P car sharing (SQ1)	Sociableness		✓	All three variations of the survey included an identical question block asking respondents how outgoing and social they perceived themselves to be. As all respondents from the three samples saw exactly the same survey items it is possible to statistically compare between groups (adopters of P2P mobility and non-adopters) and within groups (adopters of P2P ride sharing and adopters of P2P car sharing).
Adopters of P2P mobility innovations are more technophilic than non-adopters (SQ1)	Technophilia Technoscepticism		✓	Similar to the sociableness question block, all three variations of the survey included identically phrased survey items on technophilia and technoscepticism. Therefore, it is possible to statistically test for differences between the three sample groups.

Adopters of P2P mobility have higher levels of trust than non-adopters (SQ1)	Trust	✓		Survey items were worded specific to the innovation (e.g., ride sharing adopters saw "The other users of P2P ride sharing are trustworthy" while car sharing adopters saw "The other users of P2P car sharing are trustworthy". This made the survey instrument more appropriate and robust, however it is not possible to test for comparisons between ride sharing and car sharing adopters. However, understanding how adopters compare to non-adopters can reveal insights into the diffusion potential of P2P mobility.
Adopters of P2P car sharing are more likely to perceive themselves as opinion leaders than non-adopters (SQ1)	Opinion Leadership	✓		As above, survey items were worded specific to the innovation (e.g., ride sharing adopters saw "Other people trust my opinion on P2P ride sharing" while car sharing adopters saw "Other people trust my opinion on P2P car sharing". The justifications for this decision and the implications are summarised above.
Adopters of P2P mobility innovations place greater importance on their social networks as trusted information sources than do non-adopters (SQ1)	Trusted information sources	✓		As above, survey items asking about trusted information sources were worded specific to the innovation. The justifications for this decision and the implications are summarised above.
Adopters of P2P mobility innovations are more likely to have a positive perception of the attributes of P2P mobility than non-adopters (With the exception of "complexity" where the reverse is expected) (SQ2)	Relative advantage, compatibility, complexity, trialability, observability	✓		As above, survey items asking about the perceptions of the attributes were worded specific to the innovation. The justifications for this decision and the implications are summarised above.

4.3. Methodology: quantitative survey

4.3.1. Survey instrument development

Three separate surveys were designed specifically for three samples: adopters of P2P ride sharing, adopters of P2P car sharing, and non-adopters. The purpose of surveying a group of non-adopters is two-fold. First, it provides a basis to test for internal validity, i.e., to see if adopters of P2P mobility innovations are different from the mainstream population in any way. Second, by identifying in what ways this non-adopter sample displays heterogeneity compared to adopters, it can help inform an assessment of the diffusion potential of P2P mobility innovations. If there are systemic differences between adopters and non-adopters on key variables, this can mean that non-adopters possessing this trait are unlikely to become adopters in the future.

Certain question blocks were the same across the three surveys to facilitate cross-group comparisons. Table 2 shows the question blocks included in each survey and can be summarised by 4 main themes: travel behaviour and engagement with the P2P mobility innovation (either P2P ride sharing or P2P car sharing), perceptions of the attributes of the P2P mobility innovation, personality and social influence, and socioeconomic and household characteristics.

Table 2: The distribution of question blocks in the three surveys for the three target samples. Blocks in bold indicate that these are sample-specific question blocks.

P2P ride sharing adopter survey	P2P car sharing adopter survey	Non – adopter survey
Travel behaviour	Travel behaviour	Travel behaviour
Car ownership	Car ownership	Car ownership
Use of [P2P ride share platform]	**Use of [P2P car share platform]**	**Familiarity with P2P platforms, as filter questions[1]**
Use of [specific P2P ride share platform] a [2]		
Attributes of [P2P ride share platform]	Attributes of [P2P car share platform]	Attributes of P2P platforms[3]
Opinion Leadership	Opinion Leadership	Opinion Leadership
Trust	Trust	Trust
Sociableness	Sociableness	Sociableness
Technophilia	Technophilia	Technophilia
Socio economic profile	Socio economic profile	Socio economic profile
Household characteristics	Household characteristics	Household characteristics

The purpose of the travel behaviour and engagement with the P2P mobility innovation question blocks was to ascertain what types of journey adopters tend to make, and how using P2P mobility innovations fits in to their normal travel routines. The results from this question block were used to inform the development of the emissions quantifications in chapter 6. The other three question blocks were developed to respond to the research questions of this chapter.

[1] In the non-adopter survey, respondents were asked if they had previous experience using, or were familiar with, either P2P ride sharing or P2P car sharing. If the respondent stated that they were familiar with one of the innovations, they were asked questions about the attributes of that specific innovation in this block. If a respondent stated that they were familiar with both innovations, they were randomly allocated to one of the two survey blocks, following a 'quota' rule to ensure that similar numbers of respondents answered each variation. If respondents stated that they were familiar with neither of the innovations, they were automatically directed to the next question block.

[2] During the survey design phase, a relationship was established with a P2P ride sharing platform. The platform designed a block of questions to be included in the survey (the app-related question block), and in exchange, disseminated the survey to their user-base.

[3] Where non-adopter respondents indicated that they were familiar with an innovation, they were asked the exact same set of questions about their perceptions of the attributes of the innovation as the adopters were. However, in the non-adopter survey these were worded in the conditional tense (i.e. using P2P ride sharing ***would be*** convenient), whereas in the adopter survey these were worded in the present tense (i.e. using P2P ride sharing ***is*** convenient).

4.3.2. Development of question blocks

Where appropriate, question blocks were developed based on existing survey instruments. Using established and tested scales to measure these concepts means that they are more likely to be valid and reliable. Furthermore, matching question blocks with existing survey instruments can allow for comparisons of results across research studies, and this research directly builds upon precedent. The sources and development of these question blocks are detailed in appendix 1.1.

4.3.3. Pilot testing

A first draft of the survey instrument was pretested by colleagues and their feedback and comments incorporated. Next, pilot testing was conducted with a sample of users of a P2P ride sharing platform. During this phase, the variation of responses was assessed in line with the scales dictated by each question. In cases where there was little variation in response some response-items were changed to ensure that respondents could select the most appropriate response.

The data were checked to be meaningful, indicating that the respondents understood the intention of the questions. This was assessed by including reverse-worded questions (and checking that the meanings of selected responses were consistent), and question-pairs (checking that responses were consistent).

Following this pilot testing the number of questions in the survey was reduced. It was apparent that about 40% of the pilot sample of P2P ride sharers did not complete the entire survey, and 30% stopped the survey at around the same point, indicating that the survey was too long. In response, each question was re-assessed for its necessity and the order of certain question blocks was rearranged. Furthermore, messages of encouragement were added at certain points throughout the survey.

4.3.4. Sampling strategies

Samples of P2P ride share adopters, P2P car share adopters, and non-adopters were recruited for the survey. All respondents were based in the UK. Participation in the surveys was incentivised with the possibility to enter a prize draw on completion of the survey to win a £50 Amazon e-gift card. Across the three samples, there were seven vouchers available.

4.3.4.1. *P2P ride share respondents*

Sampling of P2P ride sharers was primarily achieved through a collaborative relationship with a P2P ride sharing platform, who distributed the survey to members of its users. A link to the online version of the survey was included as an email footer on all bookings-related automated emails. It is impossible to know how many people received, opened, and then read the emails, and so get a sense of the response rate, but the platform estimates that there are 664,000 registered users (in March 2019). The survey was included in the email footer from 27.03.2019 until 06.08.2019. The survey link was also promoted via the platform's social media channels. This approach yielded 256 responses.

To increase the sample size of P2P ride sharers, the survey was also distributed to members of an organisation-specific ride sharing scheme (with a total of approx. 250 users). This generated a further 55 responses. All of these additional respondents used P2P ride sharing for commuting.

4.3.4.2. *P2P car share respondents*

Four current P2P car sharing platforms in the UK were contacted to ask if they would be interested in collaborating on the survey. For various reasons all were unable to commit to doing so. As a contingency, the survey was shared in various places online targeting P2P car sharers, including Facebook groups for users of P2P car share platforms, Reddit forums, and daily Twitter posts using various hashtags. This survey was live from 24.05.2019 until 22.10.2019 and generated 62 responses.

There is a lower sample size of P2P car sharers than was hoped for and is lower than the samples of P2P ride sharers and non-adopters. However, sampling efforts had reached saturation.

4.3.4.3. *Non-adopter respondents*

The non-adopter sample was obtained through convenience sampling. The survey was promoted through various online channels, namely: Facebook groups, specific Reddit pages, twitter, and moneysaving expert, with a specific focus on online groups and forums dedicated to sustainability, sustainable mobility, car enthusiasts, and money saving. This sample is not representative of the general population. On the other hand, sampling efforts aimed to get a sample which is representative of the types of people who may adopt P2P mobility innovations. A sample size of 223 was reached between 07.05.2019 and 08.07.2019.

4.3.5. Data processing

Various steps was taken to process the data and prepare it for subsequent analysis. The results from the three separate surveys were merged and combined into one dataset. All system missing values were recoded as missing. Both the P2P ride sharing survey and the P2P car sharing contained respondents who indicated that while they have heard of the innovation, they have not used it. There were several respondents who had signed up to use either a P2P ride sharing or a P2P car sharing platform but had yet to use the innovation. In this case, it was decided to allocate these 'partial' adopters as non-adopters, given that without actual experience of using the innovations they would be unable to respond to certain question blocks appropriately. There were no respondents to the non-adopter survey who needed to be recoded as adopters.

The data were screened using various techniques to ensure internal reliability. Pairs of semantic synonyms, (i.e., 'The other users of [P2P mobility innovation] are truthful in dealing with each other', and 'the other users of [P2P mobility innovation] are trustworthy') and semantic anonyms, (i.e., 'I would find it easy to use [P2P mobility innovation]', and 'Using [P2P mobility innovation] would be difficult for me') were included in two question blocks. These are techniques to test for consistency between responses (DeSimone *et al*., 2014). If a respondent answers these questions in a conflicting way, it could indicate insufficient effort. Where there was evidence of conflicting responses these were excluded from the final dataset.

Responses were screened for 'straightlining' responding, where a respondent selects the same response consecutively over many questions (Zhang and Conrad, 2014). To avoid this occurring naturally, some questions had reverse directionality. There was evidence that some respondents had 'straight-lined' their responses; these responses were excluded from the final dataset.

The survey completion time is another screening technique for data reliability (Zhang and Conrad, 2014). The mean time taken to complete the survey was 8 minutes 47 seconds. Cases where the respondent took less than 4 minutes to complete the survey were excluded from the final dataset, given that it was highly unlikely these respondents could have completed the survey truthfully and appropriately in this time.

4.3.6. Data analysis

Various statistical techniques were used to explore the characteristics and perceptions of respondents and to compare the sample groups. The statistical tests, their associated purposes, and specific use in relation to the survey dataset are summarised in Table 3.

Table 3: The statistical tests used on the survey data

Statistical test	Purpose	Use on this dataset
Chi – square	Testing for relationships between categorical variables	Exploring how sub-samples compare on categorical socio-demographic variables.
T-test	Comparing the means of two groups, where the dependent variable is interval (or Likert scale ordinal)	Comparing how sub-samples perceive the attributes of P2P mobility innovations.
ANOVA	Comparing the means of three or more groups, where the dependent variable is interval (or Likert scale ordinal)	Comparing how sub-samples perceive the attributes of P2P mobility innovations.
Cluster analysis	Finding groups of similar cases in the data	Exploring if there are similar groups of survey respondents, based on pre-determined variables.
Principal Component Analysis (PCA)	Reducing a large number of variables into a smaller number of components	Reducing scale items into components. The component-based scores of the components identified through PCA were calculated and used in subsequent analyses. Likert scale questions were typically coded as 1=strongly agree, 5=strongly disagree. Therefore, lower component-based scores indicate stronger agreement.

4.4. Results and analysis: Who uses peer-to-peer mobility innovations?

4.4.1. Identifying groups of adopters

4.4.1.1. *P2P ride sharing*

The survey data revealed that 18.3% of the total P2P ride share sample had used P2P ride sharing in the past but have since discontinued. The respondents who fit this group were all coded as 'past-adopters'.

As a next step to identifying other groups of P2P ride sharers, a cluster analysis was used. First, the past-adopter group was removed from the total P2P ride share sample. The remaining sample was then included in a two-step cluster analysis. A two-step cluster analysis was chosen as it determines the number of clusters depending on the data. Furthermore, two-step cluster analysis can be used on a selection of variables with different levels of measurement. The variables input to the two-step cluster analysis were: age (ordinal), income (ordinal), financial situation (nominal), commute using P2P ride sharing (dummy), and car ownership (dummy).

The two-step cluster analysis revealed that there are two clusters in the data. The first cluster contains 34.8% of the respondents. This cluster is characterised by (in order of predictor importance): being younger (under 35), using P2P ride sharing for purposes other than commuting, having a lower income, living in a household with no access to a car, and describing their financial situation as 'struggling'. The second cluster contains 65.2% of the respondents. This cluster is characterised by being older (over 35), using P2P ride sharing primarily for commuting, having a higher income, living in a household with a car, and describing their financial situation as 'healthy', 'ok', or 'tight'.

The three groups of P2P ride-sharer thus are 'past-adopters', 'cluster 1', and 'cluster 2'. Given the defining characteristics of these two clusters and how they relate to use-behaviours, cluster 1 are hereafter referred to as "one-off users", and cluster 2 are hereafter referred to as "commuters". The distinctions between these types of adopters of P2P ride sharing will be drawn upon throughout this thesis.

4.4.1.2. *P2P car sharing*

Two distinct groups of P2P car sharing adopter emerged from the survey data. 31.7% of respondents had only ever used P2P car sharing as a peer-service user (i.e., renting a car from someone else). Thus, the first group of P2P car share adopter is the "peer-service user". 33.3% of respondents had only ever used P2P car sharing as a peer-service provider (i.e.,

renting their car to someone else. This group is the "peer-service provider". This group have significantly more household cars than do the peer-service users. The remaining survey respondents (35%) have either used P2P car sharing in both roles, and are thus excluded from the mutually exclusive groups, or have signed up to a P2P car sharing platform but have yet to use P2P car sharing. However, it is recognised that there is a small sample size of P2P car sharing adopters, and therefore it was decided to treat all adopters of P2P car sharing as one, coherent group for the purpose of the subsequent statistical analyses. The distinction between peer-users and peer-providers of P2P car sharing will be explored further in the following chapters.

4.4.2. Socioeconomic profiles

The socioeconomic characteristics of three samples were compared with each other and with the general population to test for representativeness. The results of this are presented in Table 4.

Table 4. The socio-economic profiles of adopters of P2P ride sharing and P2P car sharing. Values are shown in relative percentages for each innovation.

		P2P ride share adopters (%)	P2P car share adopters (%)	Non – adopter sample (%)	UK adult population (%) (Office for National Statistics data)
Gender	Male	34.7	66.7	26.7	49.4
	Female	63.8	33.3	71.6	50.6
	Non-binary / prefer not to say	1.5	0.0	1.7	No data
Age	18 – 24	8.7	5.6	11.9	7.5
	25 – 34	32.1	44.4	34.7	13.4
	35 – 44	28.6	19.4	17.0	12.7
	45 – 54	20.9	19.4	16.5	13.3
	55 - 64	9.2	5.6	16.5	12.5
	65 +	0.0	5.6	3.4	18.3
Education	Master's degree or higher	23.6	28.8	42.4	12.1
	Bachelor's degree	36.9	54.3	34.9	43.9
	Post – secondary qualifications	22.0	11.5	10.4	17.2
	Secondary school qualifications	11.3	5.7	7.6	26.0
	Other/ none of the above	1.5	2.9	0.0	6.2
Employment	In paid employment	86.2	77.1	60.5	75.2

	Unemployed	0.5	0.0	2.3	5.0
	Full time student	7.7	2.9	16.9	3.8
	Retired	1.0	5.7	3.5	18.3
	Other	4.6	14.3	16.8	3.0
Annual income (GBP, gross)	Under £9,500	4.1	0.0	6.4	9.0
	£9,500 - £15,499	4.6	11.1	12.8	14.0
	£15,500 - £24,999	12.8	5.6	10.5	22.0
	£25,000 - £49,999	31.3	33.3	27.3	30.0
	£50,000 - £74,999	21.0	16.7	18.6	14.0
	£75,000 +	12.3	22.2	11.6	11.0
	Don't know/ rather not say	13.8	11.1	12.8	No data
Financial situation	Healthy	42.1	51.4	41.4	No data
	OK	36.4	37.1	19.0	No data
	Tight	15.9	8.6	12.1	No data
	Struggling	5.6	2.9	1.7	No data
Household car ownership	Yes	90.8	100	74.8	79.0
	No	9.2	0.0	25.2	21.0

A series of Chi-squared tests and subsequent pairwise comparison tests were conducted. These show some differences as expected between adopters of P2P ride sharing and P2P car sharing, in line with the hypotheses. The results of these tests are summarised in Table 5.

Table 5: The results of a series of chi-squared tests, testing for differences between P2P ride sharers and P2P car sharers. Variables and results in bold signify that these results were significant.

Variable	χ^2	**p.**	**Pairwise comparison test (where applicable)**
Age	**25.29**	**.032**	No significant pair differences
Education (degree/ no-degree)	**4.86**	**.027**	
Employment	**12.08**	**.034**	No significant pair differences
Income	9.14	.243	
Car ownership	**5.08**	**.024**	

Age

A chi – squared test revealed a significant difference in age composition of P2P car sharers and P2P ride sharers, however a subsequent pairwise comparison test revealed that none of the pairs were significantly different from each other. This suggests that while overall there is a significant difference between the age categories of P2P ride sharers and P2P car sharers, this is not significant for any of the age categories.

It is interesting to note that the modal age category of the 2011 UK census was 35-44 (scale adjusted), with the mean age in the UK being 39.3 years (Table 4). Comparing adopters of P2P mobility with the general population, the average ages of the two adopter samples are lower than the UK average (with the largest differences in the over 65 category). While it is recognised that the sampling approach contributed to this observation, it is also evident that younger people are more likely to be adopters of P2P mobility, influenced by social and contextual factors. Regarding the 65+ age category, this group is less likely to work and therefore commute using P2P ride sharing. Furthermore, there is an observed, positive relationship between age and car ownership. Older people are more likely to own a car, and therefore are less likely to be dependent on public transport or using P2P ride sharing as a passenger. In the case of P2P car sharing, there are inherent age-restrictions; all platforms in the UK stipulate that potential peer-users must be aged under 70.

Education

A chi – squared test revealed that there were no significant differences between the highest levels of education of car share adopters and ride share adopters (χ^2=8.937, p=.443). However, the education categories were then collapsed into the dichotomous 'degree or higher' and 'no degree'. The decision to reduce these categories was based on the generalisation in DOI that "early adopters have more years of formal education than do later adopters" (Rogers, 2003, p298). Having a degree was taken to represent more years of formal education. A subsequent chi – squared test did reveal a significant difference between how likely car share adopters and ride share adopters are to have a degree (results reported in Table 5). Significantly more adopters of P2P car sharing than adopters of P2P ride sharing have a degree. The Office for National Statistics estimate that 34.4% of the UK population aged 18-64 have a degree. This is much lower than the percentage of adopters sampled who have a degree (83.1% of car share adopters and 60.5% of ride share adopters). This finding supports the expectation of DOI.

Employment

While overall there is a significant difference between the employment status of ride sharers and car sharers, there are no significant differences between any of the employment categories when tested individually. Although not significant, there is a higher percentage of students who participate in ride sharing than in car sharing. When looking at the data it became apparent that none of the students who have used ride sharing have done so in the capacity of a peer-service provider. The students sampled have only used ride sharing as a

peer-service user. The data show that the most common reason students use ride sharing is that it is "cheaper than alternatives". The fact that no students use ride sharing as a peer-service provider, and that ride sharing appeals to students as it provides a lower-cost option than alternatives, could perhaps explain why there are no students using P2P car sharing who were sampled. Typically, P2P car sharing costs more for peer-service users than does P2P ride sharing. Further, there are costly barriers to the adoption of P2P car sharing which do not exist in the case of P2P ride sharing, namely the need for a credit card and a driving license.

Income

The modal income bracket for both adopter samples and the non-adopter sample is £25,000 - £49,999. Although this income bracket is comparatively large, it does include the UK median salary £29,900 (ONS 2020). Almost a quarter (22.2%) of car share respondents report that they earn more than £75,000 annually, while only 12.3% of ride share respondents report earning this much. Despite these differences, a chi – squared test showed no significant differences between the income levels of the two adopter groups. This result does not support the hypothesis that P2P car sharers would have higher incomes than P2P ride sharers.

Car ownership

There is a significant difference between rates of household car ownership between the two adopter groups (Table 5). Adopters of P2P car sharing are more likely to live in a household with at least one car than are adopters of P2P ride sharing. This supports the hypothesis stated in section 4.2. Both peer-service users and peer-service providers of P2P car sharing need to have a driver's license (per UK platform requirements). On the other hand, it is not a requirement of peer-service users of P2P ride sharing to be able to drive. This could explain why adopters of P2P ride sharing are less likely to live in a household with a car; they do not need to be able to drive in order to participate. Indeed, it is more likely that a person in a household without a car will adopt P2P ride sharing as a peer-service user than as a peer-provider.

4.4.3. Personality characteristics

This section explores how adopters and non-adopters compare in their key personality characteristics. First, the results of principal component analyses (PCA) reducing the number of variables are presented in Table 6. Next, the results of a series of independent samples t-

tests and one-way ANOVA tests are presented in Table 7 and Table 8. The choice of statistical test is dependent on the hypothesis, which informed which data were collected and where the expected differences are. Finally, these results are interpreted and analysed in relation to the hypotheses presented in section 4.2.

4.4.3.1. *Principal component analysis results*

A series of PCA were run on the survey item scales measuring the concepts of technophilia, sociableness, trust, trusted information sources, and opinion leadership (see appendix 1.1). The results of these PCA and the resulting components which were used in the further statistical analyses are detailed in Table 6. Component loadings and communalities of the solution of each PCA are presented in appendix 2.1. Items which did not load onto the extracted components were excluded from further analyses.

Table 6: The results of Principal Component Analyses reducing the number of variables measuring the concepts of technophilia, sociableness, trust, and opinion leadership. The number of survey-items measuring each variable, the number of extracted components, the number of items which load onto each component, key characteristics of each component, and the total percentage of the variance explained by each component are presented.

Concept	Number of items in scale	Number of components extracted with an Eignen Value greater than one	Number of items which load onto component	Key characteristics of component	Total percentage of variance explained (%)
Technophilia	7	2	2 ("technophilia")	Desire to try new technologies first, investing in new technologies soon after they are available	42.9
			4 ("technoscepticism")	Take time to make decisions about technology, sceptical about new technologies, rarely invest in new technologies, prefer familiar technologies	62.5
Sociableness	4	1	3	Outgoing, enjoy meeting new people, regular social activities	63.4
Trust (P2P ride sharing)[4]	5	1	5	Other users are truthful, other users won't take advantage, other users are trustworthy, the platform provides a safe environment, the platform is trustworthy	78.9
Trust (P2P car sharing)	5	1	5	Other users are truthful, other users won't take advantage, other users are trustworthy, the platform provides a safe environment, the platform is trustworthy	74.8
Opinion leadership (P2P ride sharing)	5	2	3 ("opinion leadership")	Persuading others to use P2P ride sharing, influencing others' opinions and decisions to adopt P2P ride sharing	52.8
			2 ("non-opinion leadership"	Opinion about ride sharing is unimportant, rarely asked for advice about ride sharing	26.2
Opinion leadership	5	2	3 ("opinion leadership")	Persuading others to use P2P car sharing, influencing others' opinions and decisions to adopt P2P car sharing	55.3

[4] Note that there are two variations of the concepts of trust and opinion leadership. The survey items for these two concepts were specific to the innovation, and therefore two PCA were conducted for each concept.

(P2P car sharing)			2 (“non-opinion leadership”	Opinion about car sharing is unimportant, rarely asked for advice about car sharing	27.5

Although all the survey items measuring the concepts of technophilia, sociableness, trust, trusted information sources, and opinion leadership were taken from existing survey scales in the literature, it was decided to conduct PCA on them all as part of the data analysis process. The survey scales had not all had PCA conducted in their previous applications in the literature. Furthermore, none of the scales had been developed for the context of P2P mobility innovations. Conducting PCA on these existing scales, based on survey responses in the context of P2P mobility builds on precedent and further contributes to these scales' applications in the literature.

4.4.3.2. *Statistical analyses results*

A series of statistical tests were run on the extracted components to compare personality characteristic variables. Where the hypothesis tests for differences between adopters and non-adopters, an independent samples t-test was run (Table 7). Where the hypothesis tests for differences between all three adopter groups, a one-way ANOVA was conducted (Table 8). A summary of where each hypothesis is tested was presented in section 4.2, and Table 1 summarises where the expected differences lie and the justifications for these expectations.

Independent samples t-test results

*Table 7: The results of independent samples t-tests comparing key characteristic variables between adopters and non-adopters. Tests with a significant result are indicated by a *.*

Variable	Scale (from-to)	Non-adopter mean±SD	P2P car share adopter mean±SD	P2P ride share adopter mean±SD	t	p
Trust (P2P ride sharing)	5-25 where 5 = strongly agree and 25 = strongly disagree	7.93±2.92		5.91±4.20	-4.21	**<.001***
Trust (P2P car sharing)	5-25 where 5 = strongly agree and 25 = strongly disagree	7.52±3.26	6.32±5.09		-1.46	0.20
Trusted information sources - social network (P2P ride sharing)	1-5 where 1 = strongly agree and 5 = strongly disagree	3.36±1.11		3.68±1.22	1.77	0.08
Trusted information sources – official sources (P2P ride sharing)	1-5 where 1 = strongly agree and 5 = strongly disagree	3.89±0.96		3.87±1.05	-0.11	0.90
Trusted information sources - social network (P2P car sharing)	1-5 where 1 = strongly agree and 5 = strongly disagree	4.15±0.84	3.79±1.05		-0.97	0.34
Trusted information sources – official sources (P2P car sharing)	1-5 where 1 = strongly agree and 5 = strongly disagree	3.97±0.82	3.73±1.32		-0.97	0.33
Opinion leadership (P2P ride sharing)	3-15 Where 3 = strongly agree and 15 = strongly disagree	11.96±3.02		9.49±2.78	5.46	**<.001***

Opinion leadership (P2P car sharing)	3-15 Where 3 = strongly agree and 15 = strongly disagree	11.92±2.69	8.083±3.69		5.40	**<.001***

One-way ANOVA test results

Table 8: The results of one-way ANOVA tests comparing key characteristic variables between adopters and non-adopters.

Variable	**Scale (from-to)**	**Non-adopter mean±SD**	**P2P car share adopter mean±SD**	**P2P ride share adopter mean±SD**	**F**	**p**
Technophilia	2-10 where 2 = strongly agree and 10 = strongly disagree	7.07±2.05	4.68±2.04	6.21±2.08	**(2, 419)** 23.22	**>.001***
Sociableness	3-15 where 3 = strongly agree and 15 = strongly disagree	6.87±2.76	6.35±2.86	6.91±2.38	**(2, 425)** 0.91	0.41

4.4.4. Interpretation of statistical results

4.4.4.1. *Technophilia*

PCA revealed two components from the technophilia scale (Table 6). The technophilia component aligns with the hypothesis and expected results. The items which loaded onto the technoscepticism component were inversely correlated with those on the technophilia scale, therefore it was decided to use just the technophilia component for the next stage of analysis.

The results in Table 8 show that there is a significant difference between how the three samples perceive their levels of technophilia. A Gabriel's post-hoc test was used to determine where exactly the significant differences are between these three groups (this test is recommended for uneven sample sizes (see Laerd Statistics, 2016)). Each of the three samples is significantly different from the other two in terms of how technophilic they regard themselves to be ($p>.001$ in each case).

Adopters of P2P car sharing are the most technophilic. In the UK, P2P car sharing is still a "niche" innovation. Furthermore, as well as using the mediating digital platform, additional digital technologies including key-less access and GPS tracking are often part of the business model of P2P car sharing. This, combined with the nascency of P2P car sharing, supports the finding that adopters of P2P car sharing are the most technophilic of the three sampled groups. Adopters of P2P ride sharing are significantly less likely to view themselves as technophilic than are adopters of P2P car sharing but are significantly more likely to do so than are non-adopters. While it could be argued that P2P ride sharing is not as "technical" as P2P car sharing, P2P ride sharing does use digital platforms, and as such requires a level of digital literacy and comfort using technology. Non-adopters are the least technophilic of the three sample groups. This supports the hypothesis and DOI that early adopters are more technophilic than the mainstream population.

4.4.4.2. *Sociableness*

The results of the one-way ANOVA revealed that there are no significant differences between how the three sample groups perceive their sociableness (Table 8). The data do not support the hypotheses that adopters of P2P mobility are more social than non-adopters, nor that P2P ride sharing are more social than adopters of P2P car sharing. This could be caused by the fact that P2P car sharing does still require communication and contact (for some platforms in-person contact) between peer-providers and peer-users. This could possibly explain why there are no differences between P2P car sharers and P2P ride sharers.

As commuters use P2P ride sharing more frequently and with the same groups of people repeatedly, it could be suggested that this group of P2P ride sharers may be more social than one-off users and past adopters. Therefore, it was decided to test for further differences between these three groups of P2P ride sharing. However, a second one-way ANOVA revealed that there are no significant differences between how sociable commuters, one-off users, and past adopters of P2P ride sharing are (f=2.319, p=.104).

4.4.4.3. *Trust*

Trust in the context of P2P ride sharing

An independent samples t-test revealed that adopters of P2P ride sharing are significantly more likely to score higher on the trust scale than are non-adopters (Table 7). This supports the hypothesis.

Non-adopters had never tried the innovation, and therefore the lower trust could be acting as a barrier to adoption. As well as acting as an initial driver or barrier to adoption, previous research has found that a person's trust in both the mediating platform, and in the other users, are determining factors in the decision to continue using P2P business models (Mohlmann and Geissinger, 2018). Therefore, it was decided to further test for differences between past-users, commuters, and one-off users. Commuters are likely to share repeated journeys with the same group, in contrast with one-off users who are likely to share with strangers each time. Therefore, it could be hypothesised that one-off users are more trusting. As past users no longer use P2P ride sharing it is expected that this group are the least trusting.

There is a significant difference between how the three groups of adopters perceive trust (f=5.746, p=.004). A Tukey-Kramer post-hoc test revealed that past users (13.0909 ± 2.5485) score significantly lower on the trust scale than do both one-off users (10.347±3.8771) (p=.012), and commuters (10.337±4.318) (p=.004). This could suggest that (lack of) trust was a factor leading to past adopters discontinued use of P2P ride sharing. There is no significant difference between how one-off users and commuters score on the trust scale (p=1<.001).

Trust in the context of P2P car sharing

An independent samples t-test revealed that there is no significant difference between adopters of P2P car sharing and non-adopters (Table 7). This result does not support the hypothesis as it was expected that adopters of P2P car sharing would have a stronger perception of trust.

Given the smaller sample size of P2P car sharers it was not possible to statistically compare the peer-providers with the peer-users. This is recognised as a limitation. It is expected that peer-providers would be more trusting than peer-users, given that they are trusting strangers with their personal vehicles, and trusting the platform to act with integrity and benevolence. This potential difference in trust will be explored using qualitative methods in chapter 5.

4.4.4.4. *Trusted information sources*

A 5-item scale measuring the importance of trusted information sources was split into two components, renamed as "social network" and "official sources" (see appendix 1.1.4). A PCA was conducted on these five items, however this revealed no latent constructs. Visual inspection of the survey items revealed two thematic components which were used in the subsequent analyses. These two components are characterised below.

Table 9: the components measuring the concept of trusted information sources.

Component	**Key characteristics**
Social network	Conversations with family, friends, and colleagues; social media; seeing what others are doing
Official sources	Specialist media; general news media; organisations, service providers, local bodies

Trusted information sources in the context of P2P ride sharing

Two independent-samples t-tests revealed that there are no significant differences between how adopters of P2P ride sharing and non-adopters perceive the importance of different trusted information sources (Table 7). This result does not support the hypothesis that adopters of P2P mobility innovations place greater importance on their social networks as trusted information sources than do non-adopters.

The data in Table 7 show that P2P ride sharing adopters regard social networks as slightly more important information sources than do P2P car sharing adopters. This finding could potentially be explained by the use of workplace and location-based schemes for P2P ride sharing. The "communities" could be important sources of trusted information.

Trusted information sources in the context of P2P car sharing

Two independent-samples t-tests revealed that there are no significant differences between how adopters of P2P car sharing and non-adopters perceive the importance of different trusted information sources (Table 7). This result does not support the hypothesis that

adopters of P2P mobility innovations place greater importance on their social networks as trusted information sources than do non-adopters.

The data in Table 7 show that P2P car sharing adopters regard official sources as slightly more important information sources than do P2P ride sharers. This finding could potentially be explained by the fact that P2P car sharing in the UK is a relatively novel innovation, and currently at low diffusion in the population. Therefore, there could be a greater reliance on official media as a trusted information source as there is not enough adoption within adopters' social networks.

4.4.4.5. *Opinion leadership*

Opinion leadership in the context of P2P ride sharing

Adopters of P2P ride sharing are significantly more likely to identify themselves as opinion leaders than are non-adopters (Table 7). This result supports the hypothesis and is consistent with DOI.

Opinion leadership in the context of P2P car sharing

Adopters of P2P car sharing are significantly more likely to regard themselves as opinion leaders than are non-adopters (Table 7). This result confirms the hypothesis and is consistent with DOI.

The fact that adopters of both P2P mobility innovations consider themselves to be opinion leaders demonstrates the role of social networks and social influence in the diffusion process.

4.4.5. Summary

The results presented in this section answer the question of "who uses peer-to-peer mobility innovations" and explored adopters' socioeconomic profiles and personality traits to this end.

In line with the hypotheses, it was found that adopters of P2P car sharing are significantly more likely to live in households with multiple vehicles when compared to adopters of P2P ride sharing. Adopters of both innovations are significantly more technophilic than are non-adopters. Adopters of P2P ride sharing are significantly more trusting than are non-adopters. Adopters of P2P car sharing are more likely to perceive themselves as opinion leaders than are non-adopters.

However, the data did not support some of the hypotheses. There were no significant differences in income levels between adopters of P2P car and ride sharing (it was hypothesised that adopters of P2P car sharing would earn higher incomes given the established links between car ownership and income). There were no significant differences in sociableness between the adopter groups and non-adopters. Adopters of P2P car sharing are not significantly more trusting than non-adopters.

Furthermore, this section identified distinct groups of adopters of both P2P ride sharing and P2P car sharing, with different characteristics, motivations, and expectations of using P2P mobility innovations. These distinctions are important in the overall story of P2P mobility and will be carried through the subsequent chapters.

4.5. Results and analysis: How do adopters perceive the attributes of P2P mobility innovations?

This section explores how adopters and non-adopters compare in their perceptions of the five key attributes (identified by DOI) of P2P mobility innovations. As detailed in section 4.2 this sub question is addressed by comparing adopters of each P2P mobility innovation with non-adopters.

First, the results of principal component analyses reducing the number of variables are presented for P2P ride sharing and P2P car sharing. Next, the results of a series of independent samples t-tests are presented. These show where the adopter sample and the non-adopter sample differ in their perceptions of the attributes of P2P mobility. Finally, these results are interpreted and analysed in line with the hypotheses stated in section 4.2.

4.5.1. Principal component analysis results

A series of principal component analyses were run on the survey item scales measuring the concepts of complexity, compatibility, trialability, and observability (see appendix 1.1.3.). The results of these PCA and the characteristics of the resulting components which were used in the further statistical analyses presented in this chapter are detailed in Table 10 (P2P ride sharing) and Table 11 (P2P car sharing). Component loadings and communalities of the solution of each PCA are presented in appendix 2.1.

P2P ride sharing

Table 10: The results of the principal component analyses conducted on the survey items measuring perceptions of the attributes of P2P ride sharing. The number of survey-items measuring each variable, the number of extracted components, the number of items which load onto each component, key characteristics of each component, and the total percentage of the variance explained by each component are presented.

Attribute of P2P ride sharing	Number of items in scale	Number of components extracted with an Eignen Value greater than one	Number of items which load onto component	Key characteristics of component	Total percentage of variance explained (%)
Complexity	2	1	2	Using P2P ride sharing takes effort, and is frustrating	78.9
Compatibility	5	1	3	Compatible with daily life, fits lifestyle, fits values and beliefs, easy to use	57.5
Trialability	2	1	2	Possible to use on a trial basis, people have confidence in trialling P2P ride sharing	69.5
Observability	3	1	3	The results of using P2P car sharing are apparent, easy to explain to others the results of using P2P car sharing, easy to know if someone is using P2P car sharing	49.4

P2P car sharing

Table 11: The results of the principal component analyses conducted on the survey items measuring perceptions of the attributes of P2P car sharing. The number of survey-items measuring each variable, the number of extracted components, the number of items which load onto each component, key characteristics of each component, and the total percentage of the variance explained by each component are presented.

Attribute of P2P car sharing	Number of items in scale	Number of components extracted with an Eignen Value greater than one	Number of items which load onto component	Key characteristics of component	Total percentage of variance explained (%)
Complexity	2	1	2	Using P2P ride sharing takes effort, and is frustrating	86.1
Compatibility	5	1	3	Compatible with daily life, fits lifestyle, fits values and beliefs, easy to use	61.6
Trialability	2	1	2	Possible to use on a trial basis, people have confidence in trialling P2P ride sharing	69.3
Observability	3	1	3	The results of using P2P car sharing are apparent, easy to explain to others the results of using P2P car sharing, easy to know if someone is using P2P car sharing	49.9

4.5.2. Independent samples t-test results

A series of independent samples t-tests were run on the extracted components to compare how adopters and non-adopters perceive the attributes of P2P mobility innovations. As detailed in section 4.2, survey items asking about the perceptions of attributes were worded to be specific about P2P ride sharing or P2P car sharing. This provided a more robust dataset, and for this reason comparisons are only conducted between adopters of one innovation and non-adopters. It was not possible to draw direct comparisons between adopters of P2P car sharing and P2P ride sharing. The results of the independent sampled t-tests comparing adopters of P2P ride sharing and non-adopters are presented in Table 12 and the results comparing adopters of P2P car sharing and non-adopters are presented in Table 13.

P2P ride sharing independent samples t-test results

Table 12: The results of independent samples t-tests comparing perceptions of P2P ride sharing between adopters of P2P ride sharing and non-adopters. Significant results are presented in bold.

Variable	Scale (from-to)	Non-adopter mean	Adopter mean	t	p
RA[5] - Financial costs	2-10 where 2 = strongly agree and 10 = strongly disagree	3.40±0.80	3.86±0.89	-3.48	**.001**
RA - Environmental benefits	2-10 where 2 = strongly agree and 10 = strongly disagree	3.62±1.41	3.62±1.56	0.01	0.98
RA - Social benefits	2-10 where 2 = strongly agree and 10 = strongly disagree	4.38±1.36	4.22±1.56	0.72	0.47
RA - Social status	2-10 where 2 = strongly agree and 10 = strongly disagree	3.54±0.95	3.67±0.94	0.88	0.38
RA - Ease of use	2-10 where 2 = strongly agree and 10 = strongly disagree	5.85±1.60	5.42±1.65	1.73	0.08
Complexity	2-10 where 2 = strongly agree and 10 = strongly disagree	5.09±1.47	6.08±1.67	3.95	**<.001**
Compatibility	4-20 where 4 = strongly agree and 20 = strongly disagree	13.17±3.16	10.31±3.16	-5.87	**<.001**
Trialability	2-10 where 2 = strongly agree and 10 = strongly disagree	5.60±1.09	4.77 ±1.44	-4.58	**<.001**
Observability	3-15 where 3 = strongly agree and 15 = strongly disagree	4.15±1.31	3.67±1.43	-2.19	0.02

[5] RA = relative advantage

P2P car sharing independent samples t-test results

Table 13: The results of independent samples t-tests comparing perceptions of P2P car sharing between adopters of P2P car sharing and non-adopters. Significant results are presented in bod.

Variable	Scale (from-to)	Non-adopter mean	Adopter mean	t	p
RA[6] - Financial costs	2-10 where 2 = strongly agree and 10 = strongly disagree	3.33±0.81	3.21±0.09	-0.58	0.56
RA - Environmental benefits	2-10 where 2 = strongly agree and 10 = strongly disagree	3.88±1.78	4.36±2.12	2.10	**.004**
RA - Social benefits	2-10 where 2 = strongly agree and 10 = strongly disagree	2.13±0.79	2.21±0.96	-0.45	0.65
RA - Social status	2-10 where 2 = strongly agree and 10 = strongly disagree	3.41±0.82	3.76±1.05	-1.91	0.06
RA - Ease of use	2-10 where 2 = strongly agree and 10 = strongly disagree	5.56±1.06	3.78±0.92	1.45	**<.001**
Complexity	2-10 where 2 = strongly agree and 10 = strongly disagree	4.64±1.65	6.24±2.51	3.46	**.001**
Compatibility	4-20 where 4 = strongly agree and 20 = strongly disagree	12.81±3.69	8.46±3.31	5.94	**<.001**
Trialability	2-10 where 2 = strongly agree and 10 = strongly disagree	5.47±1.39	4.86±2.00	-1.63	0.10
Observability	3-15 where 3 = strongly agree and 15 = strongly disagree	4.32±1.65	3.36±1.47	-2.91	**.004**

[6] RA = relative advantage

4.5.3. Interpretation of statistical results

4.5.3.1. *Complexity*

Complexity of P2P ride sharing

Adopters of P2P ride sharing perceive significantly lower complexity than do non-adopters (Table 12). However, the mean score for adopters corresponds with neither agree nor disagree, instead of outright disagreeing that P2P ride sharing is complex as could be expected. To understand this result, it is important to consider what mode of transport P2P ride sharing is replacing. 94.2% of peer-service providers stated that, if no P2P ride sharing match had been available, they would have made their last journey in their own private car instead of using P2P ride sharing. However, for one-off users from car-free households, the most common alternative mode of transport was the train. These two contexts of using P2P ride sharing are associated with potentially different perceptions of complexity. Therefore, the nature of these results invited further testing to see if commuters and one-off users differ in their perceptions of the complexity of using P2P ride sharing. However, the results of an independent samples t-test show that there is no significant difference between how commuters (6.69±2.09) and one-off users (6.26±1.99) perceive the complexity of P2P ride sharing (t=.749, p=.458).

Complexity of P2P car sharing

Car sharing adopters perceive significantly lower complexity than do non-adopters (Table 13). This result supports the hypothesis and DOI that there is a negative correlation between how complex an innovation is perceived to be and its rate of adoption. However, it is important to consider the causality of this effect. It is possible that non-adopters perceive P2P car sharing to be complex and this perception is inhibiting adoption. Whereas for adopters, it is possible that their perceptions changed after having tried P2P car sharing. In other words, it is difficult to know what came first – adoption or perceptions of the lack of complexity. This could be an example of reverse causality, whereby the causal mechanism between cause and effects is contrary to common expectations.

4.5.3.2. *Compatibility*

Compatibility of P2P ride sharing

Adopters of P2P ride sharing perceive significantly higher compatibility of ride sharing than do non-adopters (Table 12). However, the mean values in Table 12 indicate that adopters do not agree that using P2P ride sharing is compatible with their daily lives. This contradicts

DOI. To explore this result further, the sample of adopters of P2P ride sharing was split into commuters and one-off users, to see if there are differences between how these two groups of adopters perceive the compatibility of P2P ride sharing based on their contexts of use. The results of an independent – samples t-test revealed that commuters (8.18±3.056) have a significantly higher perception of the compatibility of ride sharing than one-off users do (10.06±2.28) (t=-2.108, p=.04). It is possible that commuters find P2P ride sharing more compatible as they may not have to go via a platform to find matches, regularly share rides with the same groups of people, and their use of P2P ride sharing could align with a workplace norm. Indeed, the qualitative responses from the survey reveal that some adopters perceive that using P2P ride sharing has become 'part of my routine', and it is perceived by some respondents as easy to commute with colleagues. This is not the case for one-off users.

Compatibility of P2P car sharing

Adopters of P2P car sharing perceive significantly higher compatibility of P2P car sharing than do non-adopters (Table 13). This supports DOI. The mean score for adopters corresponds with 'somewhat agree' that P2P car sharing is compatible. On the other hand, the mean score for non-adopters corresponds with 'neither agree nor disagree' that P2P ride sharing is compatible. It is interesting to note that non-adopters do not regard P2P car sharing as being incompatible. This may be because, unlike P2P ride sharing, P2P car sharing is not used daily and is instead mostly marketed as an alternative to traditional B2C car rental instead of private car ownership.

4.5.3.3. *Trialability*

Although trialability is one of the five attributes recognised by DOI, defining the 'trialability' of P2P mobility is difficult. The concept of trialability is perhaps more appropriate for product – based and B2C service – based innovations. P2P ride sharing and P2P car sharing business models are not subscription based, operating instead on a 'use – as – you – need' basis. Therefore, it is difficult to pinpoint the cut-off point between *trialling* a P2P mobility innovation and *adopting* a P2P mobility innovation. An adopter could sign up to a platform, try P2P mobility, and then decide to either use it again or to not, however the fact that there are no reoccurring subscription fees makes it difficult to apply the simple "try before you sign up" approach to defining trialability. It is possible that the survey respondents perceived this ambiguity.

Trialability of P2P ride sharing

Adopters of P2P ride sharing perceive significantly higher trialability of using P2P ride sharing than do non-adopters (Table 12). Although there is a significant difference between how the two groups perceive the trialability, both adopters and non-adopters score this in a positive way, i.e., both sample groups agree that it is possible to use P2P ride sharing on a trial basis before committing to using it. As mentioned previously, this could be because of the commitment – free nature of participating in P2P ride sharing. There is no subscription and no expectation that someone must continue using it after the first time. The fact that non-adopters perceive P2P ride sharing to be trialable could indicate that they are aware that there is no ongoing commitment. Therefore, it is likely that non-adopters are more influenced to not adopt by other factors.

Trialability of P2P car sharing

There is no significant difference between how trialable adopters and non-adopters perceive P2P car sharing (Table 13). Both adopters and non-adopters have similar perceptions regarding the trialability of P2P car sharing. The mean scores of both sample groups correspond with 'somewhat agree'. Both groups generally agree that it is possible to trial car sharing, and this could be due to the nature of the business model. The fact that non-adopters are aware that it is possible to trial P2P car sharing and still decide not to try it could mean that other factors are more important barriers to adoption.

4.5.3.4. *Observability*

Observability of P2P ride sharing

Adopters of P2P ride sharing perceive significantly higher observability of using P2P ride sharing than do non-adopters (Table 12). Adopters of P2P ride sharing find that it is easier to be aware of and be able to communicate the results of using P2P ride sharing, and to know who is using P2P car sharing, than do non-adopters. The fact that participating in P2P ride sharing, by default, involves other users could explain this result. It is easy for users to be able to identify other users, given the observability here that comes with participation. This finding supports the hypothesis and DOI.

Observability of P2P car sharing

Adopters of P2P car sharing perceive significantly higher observability than do non-adopters (Table 13). This supports Rogers' expectation and the hypothesis. As non-adopters are

significantly less likely to perceive the observability of P2P car sharing this could explain why they are not adopters.

4.5.3.5. *Relative advantage*

A principal component analysis was run on a 10 - item scale measuring the relative advantage of using P2P ride sharing. Three components were extracted which had eigen values greater than one and which explained 37.8%, 12.7%, and 12.4% of the variance respectively (cumulatively explaining 62.9% of the variance). However, after inspection of the components, it was decided not to reduce these variables using principal component analysis, as the PCA returned no clear latent constructs. Reducing these through principal component analysis would lose the specificity and insight that this scale can provide. The rotated component matrix is presented in appendix 2.1.9.1.

Instead, the variables were grouped thematically, representing different aspects of the relative advantage. The survey items measured on the relative advantage scale and their component variables are presented below. Where multiple survey items form a component variable the sum scores of these survey items were used in the subsequent statistical analyses.

Table 14: The survey items mapped onto component variables measuring the relative advantage of P2P mobility.

Survey item	**Component variable**
Makes a good impression on others	Social status
Is a status symbol	Social status
Helps the local community	Social benefits
Helps people feel more connected	Social benefits
Increases autonomy	Ease of use
Is convenient	Ease of use
Is too expensive	Financial costs
Helps save money	Financial costs (inverse)
Helps address climate change	Environmental benefits
Helps protect the environment	Environmental benefits

Relative advantage of P2P ride sharing

The results of all the independent samples t-tests comparing adopters of P2P ride sharing and non-adopters' perceptions of the relative advantage are shown in Table 12.

Financial costs

Adopters are significantly more likely to perceive ride sharing as being affordable than are non-adopters. Among adopters of P2P ride sharing, the cost-saving benefits are commonly

cited by both peer-service providers and peer-service users. The financial benefits differ depending on peer-role: for peer-service providers there is the opportunity to offset the costs incurred through making a journey (e.g., petrol costs, tolls, parking costs, wear and tear), and for peer-service users P2P ride sharing is often cheaper than public transport alternatives, especially over long distances. For those peer-service users who can drive but don't have a car, using P2P ride sharing is often cheaper than renting a car (through a B2C provider). On the other hand, non-adopter's perceive P2P ride sharing to be expensive. This could indicate that the perceived costs could be acting as a barrier to adoption for non-adopters.

Environmental benefits

There are no significant differences between how adopters of P2P ride sharing and non-adopters perceive the environmental benefits of P2P ride sharing. Both groups agree that P2P ride sharing does confer environmental benefits. When adopters were asked why they chose P2P ride sharing for their latest journey, there were numerous responses citing that it is 'more environmentally friendly', and 'more sustainable'. This shows an awareness among adopters of the potential environmental benefits of P2P ride sharing. On the other hand, that non-adopters are aware of the environmental benefits but still have not used P2P ride sharing could mean the perceived environmental benefits alone are not strong enough to encourage adoption. This could also be an example of the endogeneity effect – whereby people who are more environmentally-motivated are more likely to adopt P2P ride sharing. In this case, perception of the environmental benefits cannot be used to predict adoption.

Social benefits

There is no significant difference between how adopters of P2P ride sharing and non-adopters perceive the social benefits of P2P ride sharing. When asked why adopters used P2P ride sharing for their latest journey, 'helping others' was a common response among peer-service providers. The fact that non-adopters are aware of the potential social benefits and yet have not used P2P ride sharing suggests that the perceived social benefits are not a sufficient driver to adoption.

Social status

There is no significant difference between how adopters of P2P ride sharing and non-adopters perceive P2P ride sharing to be 'a status symbol'. Both groups disagreed with this statement.

Ease of use

There is no significant difference between how adopters and non-adopters perceive the ease of use of P2P ride sharing. The mean scores for both groups correspond with "neither agree nor disagree".

Relative advantage of P2P car sharing

The results of all the independent samples t-tests comparing adopters of P2P car sharing and non-adopters' perceptions of the relative advantage are shown in Table 13.

Financial costs

There is no significant difference between how expensive adopters of P2P car sharing and non-adopters perceive P2P car sharing to be. This could demonstrate that perceived financial costs are not a barrier to the adoption of P2P car sharing.

Environmental benefits

Adopters of P2P car sharing are significantly less likely to perceive car sharing as having environmental benefits than are non-adopters. The fact that adopters do not perceive P2P car sharing to have environmental benefits could perhaps be explained by the fact that many adopters use P2P car sharing as an alternative to B2C car rental. In these instances, using P2P car sharing is a like-for-like substitution in terms of vehicle emissions. However, in cases where peer-users use P2P car sharing instead of purchasing an additional car this could be perceived to convey an environmental benefit. Therefore, non-adopters may perceive P2P car sharing as having stronger environmental benefits as they are more likely to compare P2P ride sharing to additional car ownership.

Social benefits

There is no significant difference between how adopters of P2P car sharing and non-adopters perceive the "social benefits" of P2P car sharing. The perception of social benefits is not a distinguishing characteristic of adopters.

Social status

There is no significant difference between how adopters of P2P car sharing and non-adopters perceive P2P car sharing to confer social status. The perceived social status is not a distinguishing characteristic of adopters.

Ease of use

Adopters of P2P car sharing perceive P2P car sharing as significantly easier to use than non-adopters. However, the mean for non-adopters indicates that they "neither agree nor disagree" that P2P car sharing is easy to use. This result suggests that the perceived ease of use is not a barrier to adoption, and instead there are other reasons at play.

4.5.4. Summary

The results presented in this section answer the question of "how do adopters perceive the attributes of P2P mobility innovations?". This was explored using the perceptions of the five key attributes of innovations from DOI as a framework. Comparing adopters' and non-adopters' perceptions of the key attributes predicting the adoption of an innovation reveals how important these attributes are to the adoption of P2P mobility.

In line with the hypotheses, adopters perceive the compatibility and observability of P2P mobility significantly more positively non-adopters. Adopters of P2P ride sharing perceive the trialability of this innovation significantly more positively non-adopters. Furthermore, non-adopters perceive P2P mobility innovations to be more complex than do adopters.

However, there are also results which do not support the hypotheses and the expectations of DOI. There are no significant differences in how adopters and non-adopters perceive the trialability of P2P car sharing. It was expected that adopters would perceive the components of the relative advantage significantly more positively than non-adopters. However, there were no significant differences in how adopters and non-adopters perceive the social benefits and social status of using P2P mobility. This could mean that the social benefits and social status associated with P2P mobility is not motivating enough alone to incentivise adoption. In the case of P2P ride sharing, there were no significant differences between how adopters and non-adopters perceive the environmental benefits, or the ease of use. For P2P car sharing, there were no significant differences between how adopters and non-adopters perceive the financial costs.

4.6. Discussion

This chapter explored the question of "who uses P2P mobility innovations", using P2P car sharing and P2P ride sharing as two case studies. Exploring these two different innovations facilitates a characterisation of different segments of the potential P2P mobility market. The results presented in this chapter explored how adopters of P2P car sharing and ride sharing compare both with each other and with non-adopters.

Adopters of P2P mobility innovations do exhibit some of the characteristics outlined in DOI's descriptions of early adopters. In general, the adopters of P2P car sharing and P2P ride sharing samples differ from the mainstream population in that they are on average younger, have a higher level of education, have higher rates of employment, and have higher rates of car ownership. These findings support the expectations of DOI and the findings from previous literature exploring adopter characteristics (Shaheen *et al*., 2018; Caulfield, 2006). However, this chapter also explored how the adopters of P2P car sharing and P2P ride sharing differed from each other, building understanding of the diversity of adopters. The heterogeneity of adopters is key to explaining some of the differences observed here, as each adopter group is distinct in their contexts, motivations, and perceptions. These distinct adopter groups will be carried forward through the following empirical chapters.

Some adopters' perceptions of attributes align with the expectations of DOI. Notably there were no significant differences between adopters' and non-adopters' perceptions of some dimensions measuring the relative advantage of P2P mobility innovations. That non-adopters and adopters do not differ in their perceptions of the relative advantage could mean that non-adopters are not adopting P2P mobility innovations for other reasons. If non-adopters perceive P2P mobility to have specific advantages to alternatives, then there must be further factors inhibiting adoption. Existing literature suggests that reasons which may inhibit adoption of P2P car sharing and P2P ride sharing beyond the perception of attributes include the anticipated stress (of P2P car sharing)(Valor, 2020); concerns around personal safety (of P2P ride sharing)(Mattia *et al*., 2021), and the need for a local critical mass (Münzel *et al*., 2019; Wells *et al*., 2020). These themes, as well as others, shall be further explored in subsequent chapters.

Some differences observed in this chapter may be due to the differences in where these two innovations are on the diffusion scale. P2P car sharing was brought to the UK market in 2010 (through the platform WhipCar). P2P ride sharing on the other hand has been present for decades longer (through community schemes, notice boards, workplace schemes, among others), with the internet enabling potential matches on a much larger scale. Some workplace-based P2P ride sharing schemes operate independently of an online, mediating "platform". Recognising the diversity of business models bringing P2P ride sharing to adopters, with the distinction between internet-based platforms connecting strangers, and offline-based platforms connecting colleagues, invites the question of where P2P ride sharing lies on the diffusion curve. Furthermore, the different ways in which P2P ride sharing schemes operate may lead to different types of people using and perceiving P2P ride sharing

in different ways. While this survey was designed for and advertised to adopters who use online P2P ride sharing platforms, it would be an interesting area for further research to explore the possible differences between adopters of each business model. This could reveal if there are further distinctions between adopters of P2P ride sharing and could help inform differentiated and specific strategies to further facilitate adoption.

The fact that P2P car sharing is much newer to the market, and at present has a much smaller market penetration than P2P ride sharing, means that adopters of P2P car sharing are more likely to fall into the true "early adopter" category. This is demonstrated through differing sociodemographics including education and income levels, personality characteristics including technophilia, and higher perceptions of the attributes of P2P mobility. Furthermore, the results from this chapter, particularly regarding perceptions of attributes such as trialability, raise some interesting questions surrounding at what point one is considered an adopter, particularly in the case of P2P service-based innovations, where the lines between adopter and non-adopter are not as clear cut as they would perhaps be for a product-based innovation.

While it is difficult to find data pertaining to the current adoption levels of P2P car sharing and P2P ride sharing in the UK, a 2017 publication from the Office for National Statistics estimates that 22% of UK adults have used an 'intermediary website or app' to arrange P2P transportation, as either a provider or user (Beck, 2017). While this value appears high, the definition of the sharing economy used by the ONS does not specify the need to use idle capacity (as discussed previously). Therefore, these values include users of Uber and other ride – hailing apps. The 2016 UK Understanding Society Survey estimates that 0.55% of UK adults use P2P ride sharing services. This means that approximately 221,800 adults in the UK aged 18 – 70 have participated in P2P ride sharing services. There are no analogous estimates in the literature for P2P car sharing adoption in the UK, although the population of P2P car sharing adopters is smaller than that of P2P ride sharing adopters.

At the time of writing, ten P2P car sharing platforms had launched in the UK since 2010, with four platforms still operating. The high rate of failure of these platforms reaffirm that P2P car sharing is early in the diffusion curve. A high tolerance for risk and willingness to tryinnovations which may ultimately fail is a defining characteristic of the "innovators", according to DOI. P2P car sharing adopters can thus be regarded as innovators and early adopters, whereas most P2P ride sharing adopters, especially in the case of commuters, would fall into the later adopter categories.

Some of the differences between how the attributes of P2P car sharing and P2P ride sharing are perceived by adopters could be due to the different business models. P2P ride sharing is a service-based business model, where the "service" is a journey in a shared vehicle, whereas P2P car sharing is a product-service business model, where the "product" of access to a personal vehicle provides the service of mobility. P2P car sharing provides the users with autonomy and privacy, which P2P ride sharing does not. These differences can be used to interpret some of the results. P2P car sharers perceive P2P car sharing to be easier to use than do non-adopters, and this difference is not seen for P2P ride sharers. It could be suggested that this difference is attributable to the desire for autonomy and privacy. From a peer-user perspective, P2P car sharers have the autonomy to decide where and when they want to travel, as well as the privacy of having sole, non-rival access to a vehicle. This differs for peer-users of P2P ride sharing, who do not have the autonomy over these decisions.

The concept of trust emerged as a key dimension of difference. Trust is an important element in DOI and impacts adoption through trusted information sources and trusted social networks. This chapter revealed key differences in perceptions of trust. These differences present across innovations (i.e., differences between adopters of P2P car sharing and P2P ride sharing), and within innovations (i.e., differences between commuters and one-off users of P2P ride sharing). While this chapter has identified these differences in trust and explored how information flows influence adoption, the next chapter will explore the reasons behind these differences, as well as the importance and implications of these differences with regards to the role of trust in the adoption and diffusion of P2P mobility innovations. Furthermore, the next chapter will explore the role of trust beyond other users, using an additional analytical framework.

Chapter 5: Exploring the role of trust in the adoption of P2P mobility innovations

5.1. Introduction and rationale

This chapter addresses the question "***what is the role of trust in the adoption of P2P mobility innovations?***" The concept of trust, in the form of trusted information sources, is pivotal to the diffusion of innovations (Rogers, 2003). Trusted information sources play an important role in the knowledge phase of the innovation-decision process and can ultimately impact a person's decision to adopt an innovation or not. Furthermore, the concept of trust has been identified as one of the most important long-term drivers of success of peer-to-peer platforms (Cook and State, 2015). However, there are numerous other ways in which trust can play a role in the adoption of P2P mobility innovations which go beyond the scope of DOI and trusted information networks. Some of these relate to personal dispositions to trust: as examples, some people are more trusting than others, and some people's trust is negatively affected by bad experiences more than others. Some of these relate to a person's contextual situation: as examples, some people are in social networks with more trusted others, and some people may have had bad experiences resulting in reduced level of trust.

Hawlitschek, Teubner, and Weinhardt (2016) conceptualise trust in terms of three dimensions, namely *integrity, benevolence,* and *ability*, and differentiate between three targets of trust: *trust in the person* (i.e., other users of the platform*), trust in the platform itself*, and *trust in the product* (Figure 6).

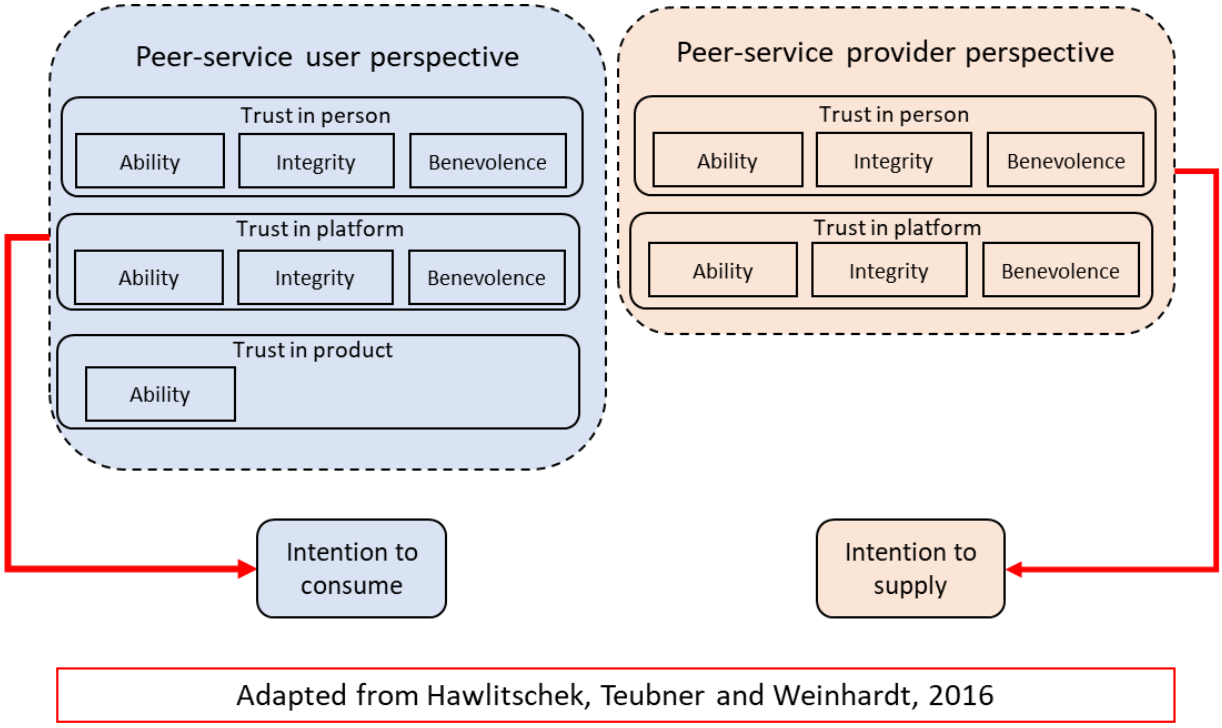

Figure 6: conceptual framework of the dimensions and targets of trust in P2P transactions.

The interpretations of the three dimensions of trust differ slightly depending on the target of trust. *Ability* describes being able to complete the P2P transaction safely and properly. This could be another person's driving ability, the ability of a platform to facilitate suitable matches, or the ability of the vehicle to complete the journey safely. *Benevolence* describes keeping other parties' interests in mind. *Integrity* describes the notion of "keeping one's word" (p3). Hawlitschek, Teubner, and Weinhardt (2016) recognise that the dimensions of benevolence and integrity are closely related.

Trust in person (other users of a platform) is facilitated through various forms of building trust between strangers. An example is online reputation systems, which includes ratings and reviews, photos, and building personal profiles (see Ter Huurne *et al*, 2017; Teubner, 2014). These facilitate the dimensions of *integrity*, *ability*, and *benevolence*. *Trust in the platform* can be increased through its *ability* to match peer-users and peer-providers, and through its *integrity* and *benevolence*, with regards to how it collects and handles personal data, maintaining user support services, user costs, and general reputation (Hawlitschek, Teubner, and Weinhardt, 2016). Finally, *trust in product* refers to how peer-users perceive the *ability* of the product to fulfil the desired service. As the product is an inanimate object, it cannot in itself act with *integrity* or *benevolence,* and thus it is only the dimension of *ability* that is relevant for trust in the product. Furthermore, as the peer-service provider is the supplier of the product, and this is a priori a product that they own, Hawlitschek, Teubner, and Weinhardt regard that it is not appropriate to assess their trust in the product. It could be argued that, in the case of P2P mobility, car owners do have to trust in their own vehicle's resilience and reliability but given that they do participate in P2P mobility this is assumed to be the case.

This aim of this chapter is to explore the role of trust in the adoption of P2P mobility innovations. While trust has been identified as crucial to the success of P2P platforms, little is known about how trust is established in this context (see Ter Huurne *et al*., 2017), and more specifically in the context of P2P car sharing and P2P ride sharing. Furthermore, as identified in chapter 4, adopters of these platforms are heterogeneous, and the diversity, both among and between different groups of adopters adds complexity to this presently understudied area of research. These different groups may have unique perceptions of the concepts related to trust, and the relative importance of these in the adoption of P2P mobility innovations. The analytical framework of trust depicted in Figure 6 will be used to provide a framing for this chapter.

5.2. Hypotheses

P2P transactions are reliant on being matched with someone performing the complementary peer-role; every peer-user needs a peer-provider and vice versa. Each of these peer roles will have unique concerns regarding trust in the other users, the platform, and the product. Concerns regarding trust are asymmetrical between the two peer roles, with different contexts, risks, and perceptions associated with each peer role.

Both P2P car sharing and P2P ride sharing require high levels of trust. However, a key difference stems from where the emphasis on "sharing" lies. Furthermore, there are differences for peer-users and peer-providers within each of these innovations. P2P car sharing offers peer-users sole, rival access to a peer-providers' vehicle. In the UK, the platforms offering P2P car sharing all include insurance for the vehicle being rented and have criteria specifying the condition of the vehicles which can be offered. On the other hand, peer-users of P2P ride sharing "share" space inside their vehicle during a journey. The person with whom they are sharing could be someone who is from the same community (in the case of workplace schemes and location-based schemes) or could be someone who is a potential stranger (in the case of national networks). These differences in what exactly is being shared could lead to differences in the relative importance of the dimensions of trust, and the targets of trust. ***Specifically, it is expected that peer-users of P2P car sharing place greater emphasis on trust in platform, whereas peer-users of P2P ride sharing place greater emphasis on trust in person.*** From the opposite perspective, while peer-providers of P2P car sharing share rival access to their vehicle with strangers, the platform is the mediatory mechanism and should protect the interests of peer-providers. Peer-providers of P2P ride sharing share their journey, and the physical space within their vehicle with other people. ***It is therefore expected that peer-providers of P2P car sharing place greatest emphasis on trust in platform, and peer-providers of P2P ride sharing place greatest importance on trust in person.***

Another key difference between P2P car sharing and P2P ride sharing relating to the concept of trust centres on the specific type of business model of these two innovations. P2P car sharing is a product-service system, where users rent the product (the vehicle) to deliver the required service (the journey). P2P ride sharing is a service-based business model, where the service is a journey in a shared vehicle (either as a driver or as a passenger). The difference in these business models could have implications for differences in trust. This is potentially due to the differences in autonomy that these two business models offer

adopters. For P2P ride sharers (both providers and users), there are inherent trust requirements that the other people sharing the journey will enable the journey to be completed on time and safely. Therefore, ***it is anticipated that P2P ride sharers regard trust in person as being highly important, particularly with regard to the integrity and benevolence of others***. However, P2P car share users are still dependent on others providing a suitable vehicle, in a suitable location, and at a suitable time, thus bringing into question the true extent of autonomy. For this reason, ***it is anticipated that peer-users of P2P car sharing will also place importance in trust in person, but that this manifests through the dimension of ability.*** P2P car sharers (users) have the autonomy associated with having rival access to a vehicle, but given that they travel without the vehicle owner***, it is expected that peer-users of P2P car sharing emphasise trust in product (the vehicle)***. This is particularly important in the context of the condition and safety of the vehicle, and differs from P2P ride share users, who travel with the vehicle owner.

Finally, the COVID-19 pandemic has changed how inter-personal trust is generated and perceived. This research chapter was designed in spring 2020 and conducted in summer and autumn 2020. At this time the UK was under COVID-19 restrictions. While recognising and respecting the devastating human impacts of COVID-19, it is also possible to frame the pandemic as a shock event, disrupting societal norms and practices. There has been much discussion and speculation as to what a "post-COVID" (and at times indeed a "COVID") world could look like, and exploration as to whether the COVID-19 pandemic can trigger systemic changes to our systems of production and consumption (Mont *et al*., 2021). Acknowledging that the economic, social, and political impacts of COVID-19 are likely to be felt in the long-term, both this chapter and chapter 6 explore the future of P2P mobility against this backdrop. In this chapter, the impacts that COVID-19 has had on trust, as a key driver and barrier to the adoption of P2P mobility are explored. ***It is expected that among adopters of P2P ride sharing, the pandemic has led to reduced trust in person***. However, given that P2P car sharing offers peer-users access to a private vehicle (and as found in chapter 4 is often used as an alternative to public transport), ***for P2P car sharers it is anticipated that the pandemic has increased trust in the product (P2P car sharing), and the platform.*** The expected differences in the objects of trust here stem from the differences in business models between these two P2P mobility innovations.

5.3. Methodology: Qualitative focus groups

Focus groups are an appropriate qualitative data collection method in instances where the construction of meaning among participants is important in itself (Bryman, 2016). Indeed, focus groups have been described as "collaborative research performances", and it has been stated that it is the interactions among the participants, instead of between participant and researcher, which is at the root of data generation (Moore *et al*., 2015, p17). In other words, the social dynamics among the participants are themselves meaningful. For this reason, focus groups are most often conducted with purposely selected individuals who all come from a similar population (Nyumba, 2018). P2P mobility innovations do not occur in a vacuum – each P2P transaction is reliant on others taking on the complementary peer role in the same space and time. Therefore, focus groups are an appropriate method to use for this research project, as the joint construction of meaning within the focus group emulates what occurs during P2P transactions.

Participant interaction in focus groups allows for further 'probing' than in individual interviews and participants can challenge each other. It has been suggested that this means that people are more likely to say what they really think when compared to conventional one-on-one interviews, as participants are required to justify their views when under scrutiny from members of a similar group (Plummer D'Amato, 2008). However, it is important to point out that the inverse may be true in some cases; participants with "outlier" opinions may indeed be less inclined to share, to try to conform to the appearing group norm (Stewart and Shamdasani, 2014).

Protocols suggest that the topic guide for focus groups be less prescriptive than those designed for one-on-one semi-structured interviews (Kamberelis and Dimitriadi, 2011). This allows participants to bring issues that they find relevant to the fore and can instil a greater sense "ownership" of the focus group than would occur in an interview.

Online focus groups are an emerging methodology. The benefits of online focus groups (vs. in person focus groups) include the overcoming of spatial (and in some cases, temporal) barriers. It is not necessary for participants to be in the same location, meaning that participants can join regardless of where they are. In a similar vein, by hosting focus groups virtually, some authors have stated that it makes them more accessible to groups of people who otherwise would be unlikely to participate (Moore *et al*., 2015). It has been suggested that being able to participate from home may encourage participants to feel more confident expressing their true opinions, and they could be less likely to filter their contributions to

conform to the dominant narrative of the group. This in turn could result in a more honest and open discussion arising from the focus group (Moore *et al*., 2015). As well as the apparent benefits to participants of virtual focus groups, it has been suggested that they are cheaper for the facilitator to run, given that there is no costs of venue hire (although it is important to note that online focus groups aren't without associated costs, including the costs of hosting software, and incentives for participants).

On the other hand, there are potential drawbacks of using online instead of in-person focus groups. As well as being more accessible to participants, there is the potential for digital exclusion (Moore *et al*., 2015). Online focus groups rely on participants having access to high-speed internet and being comfortable and proficient using digital technologies. There are risks that discussions could become disjointed in online focus groups which use voice and video technologies, and in the case of text-based online focus groups, multiple lines of conversation happening in parallel (Bryman, 2016). Finally, there is a risk of losing non-verbal cues and body language that are important communication tools.

Online focus groups and can be either synchronous or asynchronous in form. Synchronous focus groups occur in real time, and most often make use of video and voice technologies, although text-based synchronous focus groups do exist (Stancanelli, 2014). Asynchronous focus groups can take a variety of forms but are characterised by the fact that participants can participate in their own time. Common examples of asynchronous focus groups include ongoing chat conversations or email threads over the period of multiple days. While synchronous online focus groups emulate in-person focus groups more closely, much of the literature into online focus groups centres on those taking an asynchronous form.

Many of the potential methodological drawbacks of online focus groups outlined above can be negated by running a synchronous focus group that makes use of voice and video technologies. In focus groups of this type, participants communicate verbally with each other, and are able to see each other. This allows participants, and the facilitator, to recognise and notice non-verbal communication. Furthermore, by hosting the focus group with video and voice, there is a reduced risk of parallel conversations happening when compared with text-based focus groups.

5.3.1. Focus group design

Seven online focus groups were designed and conducted. The decision to use online focus groups for this project, instead of in-person focus groups was due to a number of factors. Recruitment for the focus groups was primarily focussed on respondents who had previously

completed an online survey (as described in chapter 4), and so could be identified as belonging to a specific adopter group. The survey was open to adopters of P2P car sharing and P2P ride sharing who live in the UK, and therefore the pool of potential focus group participants was geographically dispersed. Using online focus groups instead of in-person focus groups meant the focus groups were not geographically constrained. Having access to a pool of participants from across the country could have the added benefit of accessing participants who use P2P ride sharing and P2P car sharing in different contextual settings, leading to a wider diversity of experiences. As shall be further explored in section 5.4, respondents who used both P2P ride sharing, and P2P car sharing, in London (or other major cities), reported different motivations, challenges, and overall experiences than those who did so in smaller cities and towns, or in rural settings.

It was originally planned to conduct one in-person focus group as a control for the topic guide and methodology, however COVID-19 restrictions in 2020 made this impossible. However, multiple online focus groups were conducted with certain adopter groups which fulfilled this purpose.

There were two main research goals for the focus groups. First, the topic guides were designed to explore topics introduced in the survey in more depth. This enabled interpretive and causal relationships between constructs to be determined. While the survey did include questions about trust and social relationships, these are constructs that are never developed in a vacuum; instead, it is through connection with others. Therefore, addressing these concepts in the setting of a focus group would be an appropriate way of matching research goal with research method. To this end, a series of broad guiding questions were developed to structure and inform the specific topic guides for each of the focus groups. These guiding questions covered the themes of trust (in other users, in the platform, and in the product itself), and sociality and relationships with others, both of which were first introduced in the survey. The second research goal was to explore additional topics which were not addressed in the original survey. A further set of guiding questions were developed on themes including the importance of contextual factors, institutional factors, and agency. The specific topic guides for each of the focus groups can be seen in appendix 5.1.

5.3.2. Participants

Participants for the online focus groups were recruited in two ways. Survey respondents who fit the adopter profiles outlined in chapter 4, and who had indicated that they would be happy to be contacted for further research, were contacted. Additionally, the focus groups

were advertised online, specifically in relevant Facebook groups (*Carshare UK*, and *The Pasty Connection* to recruit for one-off ride-sharers, and *Getaround Owners UK*, and *Turo Hosts UK*, to recruit P2P car-sharers) and reddit forums (*r/Turo*). Participation in the online focus groups was incentivised with a £25 Amazon e-gift card for all participants. Participants were opportunistically sampled and are not representative of the general population. It is very rare to conduct a focus group that is truly representative of the general population as this methodology is primarily used with specific populations in mind (Barbour, 2018).

While most in-person focus group literature suggests a group size of 5 – 10 participants (Liamputtong, 2011), Forrestal *et al*. (2015) suggest running online focus groups with fewer participants, with a minimum of 3 or 4 participants. Smaller group size enables discussions to flow more naturally given the online format and can help each participant feel more engaged with more opportunity (and perhaps pressure) to speak. The numbers of participants in each of the focus groups in shown in Table 15.

5.3.3. Materials and procedures

Between May 2020 and October 2020, 7 online focus groups were conducted with groups of adopters of P2P ride sharing and P2P car sharing. Table 15 shows the compositions of these focus groups.

Table 15: The composition of each of the focus groups.

Adopter group		Date	Number of participants
P2P ride sharing	Commuters	26.05.2020	6
		16.06.2020	3[7]
		30.09.2020	4
	One-off users	22.06.2020	4
		23.06.2020	4
P2P car sharing	Peer-service users and personal providers	07.07.2020	6
	Fleet providers	21.10.2020	4

Focus groups were conducted with two distinct groups of P2P ride sharing adopters, commuters and one-off users, as identified in chapter 4. Additionally, there were two

[7] *There were originally three participants in this online focus group; however, one participant was having connectivity issues and was not able to participate throughout the duration. This focus group was subsequently repeated with new participants.*

distinct types of P2P car sharing peer-provider included in the focus groups. "Personal providers" rent out their own, private car on P2P car sharing platforms, whereas "fleet providers" are adopters who purchase additional vehicles for the sole purpose of renting them on P2P car sharing platforms. Separate focus groups were conducted with these two types of peer-providers as it was believed that this could provide further insights and dimensions for comparison.

While much of the online focus group literature centres on asynchronous focus groups, Forrestal *et al*. (2015) review the use of online synchronous focus groups as a methodology and present some principles for best practice. Potential participants were contacted with basic information about the focus groups (including the requirements of the hosting software) and a request to respond by a certain date if they would be interested in participating. For more details on this procedure please see appendix 1.2.

The focus group opened with a brief introduction about the purpose, and a reiteration of key points from the consent form (which participants had all read and agreed to prior to joining the focus group). All of the online focus groups were hosted synchronously on Microsoft Teams. Participants were encouraged to have their video on during the call. All discussions took place verbally with no use of the chat function. Focus groups were recorded using Microsoft Teams integrated recording function. Recordings were transcribed verbatim, using anonymised identifiers to distinguish between participants. As the video feed was also recorded, the transcriptions include notes when participants display non-verbal cues in response to others (for example, nodding the head, and shaking the head).

5.3.4. Data analysis

Transcripts were analysed using the qualitative data analysis software NVivo 12 Pro. Transcripts were coded iteratively. First, a series of top-level, a priori, codes were developed in line with the research aims of the focus groups (presented in appendix 5.2). During this process, in-vivo codes emerged, which were added to the coding frame. Following the suggestion by Thornberg and Charmaz (2014), codes were developed as gerunds where possible, to focus on process and action. Each transcript was top-level coded twice, to ensure reliability and consistency of the assigned codes. Second, initial codes were organised into themes and sub-themes, to develop a coding hierarchy. This process enabled relationships between concepts to be visualised. During the coding process, constant comparison practices meant some codes evolved to incorporate others, while some diverged into multiple codes.

Once all transcripts were coded, a series of tables were constructed in Microsoft Excel in order to reduce the volume of data and extract key points. Furthermore, these tables enabled comparison between how different adopter types perceived certain concepts. Constructing tables of this kind facilitates the process of constant comparison (Gibbs, 2018), and elevates analysis from content to meaning, or from the descriptive to the analytical.

Using tables to organise emerging concepts assists the process of constant comparison at both the inter-group and intra-group levels. There is much discussion surrounding the extent to which focus group analysis should be conducted at the level of the individual, or at the level of the group, to which there is no "one-size-fits-all" approach (see chapter eight in Barbour, 2018). While Stewart *et al*., (2007) argue that, given the unrepresentativeness of focus group participants relative to the larger population, it is "questionable" to make group level inferences based on the individual voices represented in the focus group. They suggest that individual perspectives should be the focus of analysis, where each individual represents a certain demographic, lifestyle, or attitudinal segment. On the other hand, Bryman (2016) argues that the value of focus groups lies in the joint construction of meaning, and thus the group should be the main unit of analysis. Taking a middle-of-the-road approach is Barbour (2013, 2018), who advocates for focusing on patterns to develop a deeper understanding of the patterns that emerge from the data. Here, patterns can be consensus or disagreement between group members, and in the case of disaccord, the individual voices that disagree are insightful data (Barbour, 2018). Indeed, Barbour (2013) highlights that tensions and dilemmas among the group can aid the researcher in understanding and conceptualising patterns.

The focus groups were analysed using this patterning approach, where consensus or disaccord (with explorations of both sides), within groups were the main unit of analysis. Given that there were seven focus groups, the findings from within groups were compared with each other in a similar vein, i.e., drawing out patterns across the focus groups.

5.4. Results and analysis

Figure 7 shows the concepts related to trust which emerged from the focus groups. These are mapped on to the theoretical framework of the dimensions and objects of trust. The concepts and the relationships between them are presented in the form of influence diagrams. A legend detailing what each shape represents is presented at the bottom of Figure 7.

There are four separate influence diagrams, shown on a 2x2 matrix. The dimensions of this matrix are user/provider, and car sharing/ride sharing.

Influence diagrams are visual representations of decision scenarios (Hall, 2010). In this instance, the ultimate decision is the intention to consume (peer-users) or the intention to supply (peer-providers). The other nodes (or shapes) represent the prior decisions, uncertainties, and inputs and outputs which influence the ultimate decision of "intend to consume" or "intend to supply". Arrows in an influence diagram represent influence. Influence can work in different directions between different nodes, explaining why not all arrows in all diagrams lead to the ultimate decision of "intend to consume" or "intend to supply". There are two colours of influence arrow in the diagrams. Red arrows represent influence between nodes. Blue arrows represent the ways in which these relationships map onto the dimensions and objects of trust presented in the theoretical framework.

The rest of section 3 will compare and contrast how different adopters and groups of adopters perceive and conceptualise trust, in line with the nodes in Figure 7. The nodes selected as the units of analysis for this chapter were chosen as they account for the main variations in influence over an adopter's intention to consume or intention to supply. These are personal safety, in-person interactions, driving quality, reviews and ratings, reputation of the platform, finding matches, and reliability.

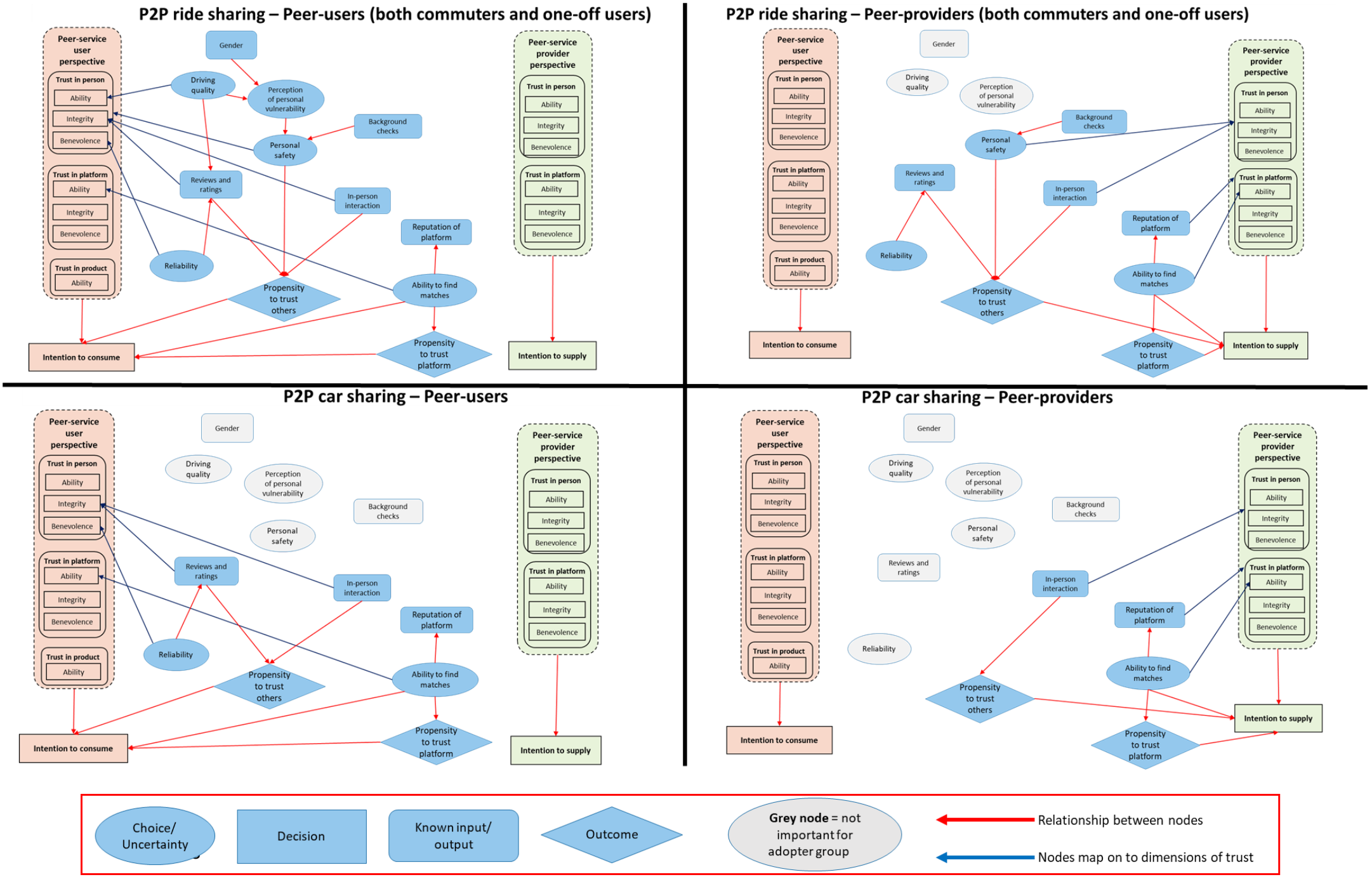

Figure 7: Four influence diagrams summarising the main findings from the focus groups with adopters of P2P mobility innovations. The influence diagrams are organised by innovation, and peer-role.

5.4.1. Personal safety

Numerous concerns arose during the focus groups relating to meeting, and trusting, other users of P2P ride sharing platforms. However, there were differences in how different types of P2P ride sharer, i.e., commuters and one-off users, perceived the relative importance of these concerns.

All of the commuters who participated in a focus group shared their journey with the same person or group of people repeatedly, whereas none of the one-off users had experience of a "repeat" journey with someone and were thus meeting a new person (or people) for every journey they made. This difference in knowing others previously could explain the different directions discussions in these focus groups took regarding the concept of trusting others. Among the commuters, there was a mixture of: people who knew their match previously, people who met their match through their workplace-specific rideshare scheme, and people who met their match through other platforms (and in this case often worked at different workplaces to their matches). The majority of commuters who participated in the focus groups fit into the first and second of these categorisations. For the commuters who did not know their match previously, but met them through a workplace-specific scheme, this provided a sense of reassurance about the integrity of the person *"you know you're not going to get into the car with an axe murder, probably".* This demonstrates a sense of trust built between commuters from the same workplace, from the familiarity that this brings. Further, many commuters who ride-shared as part of a workplace-specific scheme alluded to it being part of the company culture, or norm. Norms of the social system, in this case the workplace, are depicted by Rogers (2003) as a prior condition in the innovation decision process, which can make someone more amenable to the adoption of an innovation. Additionally, if ride sharing is a workplace norm this further contributes to creating trust among the participants, *"if you're working in the same place there's going to be an automatic level of common interest there, which may help build rapport with people"*.

There was disagreement among participants who did use a workplace-specific scheme about whether they would feel comfortable sharing with someone external to work who they met through other platforms. The majority of participants agreed that they would not feel comfortable with this, and value the assurances that comes through sharing with someone from the same workplace. However, there were participants for whom the potential benefits of ride sharing outweighed this, "*as long as they can share the driving I don't care*". Many commuters who participated in the focus groups were part of commuting "groups" and

alternated the roles of driver (peer-provider) and passenger (peer-user). In this case, the ability to split the responsibility for driving with someone was more important than that person being part of the same community.

While one-off users of P2P ride sharing almost always share with strangers, some participants reached the consensus that, through being matched via a certain platform, it can be assumed that matches hold similar personal values. When talking about a P2P ride-sharing platform based in the south-west of the UK, one participant stated, *"…most people are from Cornwall, so there is a similarity in attitude between people",* and the other participants with experience of using this platform agreed. Similarly, in another focus group with one-off ride sharers it arose that these platforms attract certain groups of people, namely "*students, or millennials trying to save money, I'd say like 35 and under…*". It is important to note that the participants in this particular focus group all fit this age demographic. These two quotes can provide examples of finding things in common with other users, as a means to developing trust. While there is an explicit role of community (specifically workplace community) in building trust between commuters who use P2P ride sharing, there is also evidence of community (finding things in common/ group identity) playing a part in one-off ride-sharers predisposition to trust other users of the platform.

There was agreement among one-off users that the platforms could do more to strengthen this sense of community and provide reassurance *"nothing is being tracked … there is no code of conduct, and even if there was how would you enforce it?"*. Furthermore, none of the platforms have identity checks or any vetting process, and the issue of whether someone was actually who they say they were was raised as a safety concern. Similar discussions around tracking journeys took place in the P2P car sharers focus groups, although from a different perspective. Most platforms of P2P car sharing use GPS technologies to track the vehicles, as well as identity checks with drivers' licences, and this was generally regarded as a means of reassurance to providers. However, this highlights the difference between P2P car sharing and P2P ride sharing in terms of *what* is being shared, and where the reassurances of trust operate. In the case of P2P ride sharing, tracking technologies and identity verifications would help to develop a sense of personal safety, especially for one-off users travelling with strangers. On the other hand, P2P car sharing platforms typically do use tracking technologies and identity verifications, but the focus of this is to provide reassurance that the vehicle will be returned in good condition.

Both one-off ride-sharers and commuters shared concerns that journeys are not being tracked, and there are no background checks on users. For these groups, the lack of verification calls into question the *integrity* and *benevolence* of the platform. Furthermore, in both groups the idea of platforms vetting users and performing simple background checks was raised as a means to increase trust, both in terms of the *integrity* and *benevolence* of the platform, and the *integrity* and *benevolence* of the other users. Where a platform links their members profiles with their social media profiles, participants generally regarded this as a way of building trust, "*I like the fact I can go on someone's Facebook profile … so yeah, the platform definitely made it feel much safer*". However, as shall be further explored in section 5.4.4, the presence or absence of this feature does not appear to have a direct influence on an individual's decision to use, or not use a certain platform, and instead it is regarded as somewhat of a "bonus".

Most one-off ride sharing participants agreed that first impressions are very important in building a sense of trust with someone, "*you can usually gain trust within the first 30 seconds of meeting someone", "Yeah you can get a vibe*". This notion of trusting "gut instincts" was raised by participants in both focus groups with one-off ride-sharers. Interestingly, there appeared to be consensus that intuition played a more important role in developing trust in a potential driver, than did prior reviews and ratings. As one participant put it, "*you can't tell someone's driving style from a profile*". This highlights the asymmetrical risks for the driver and passenger. With the exception of one participant, all one-off ride-sharers did so exclusively in the peer-role of a passenger. The participants all agreed that the driver had more responsibility (to drive safely), and the onus was on them to build trust*, "as a driver you also have to build more trust with the passenger, that they can trust your driving abilities and driving style, so you have to build this trust. It's not just good behaviour, it's much more than this".* This quote illustrates the sense of vulnerability that passengers of one-off journeys can feel, in terms of their personal safety and trusting the driving ability of the driver.

Both commuters and one-off ride-sharers discussed the relationship between gender and perceived vulnerability, in relation to trusting strangers. The idea of one-sided vulnerability was further explored in these discussions about gender, and the participants agreed with the perception that it is inherently safer for men to ride share than it is for women. Both men and women participants agreed with this, with one woman participant stating that her friends "*thought I was crazy*" for using P2P ride sharing. This demonstrates that the feeling that women ride-sharers are more vulnerable than men extends beyond the P2P ride sharing

community to wider society. Furthermore, this suggests that society regard women using ride sharing as something inherently dangerous. Interestingly, one of the focus groups with commuters also had discussions around the relationship between perceived personal safety and gender. At one participant's workplace, commuters are able to filter potential matches based on gender. In response, a woman participant shared that she never meets potential matches alone for the first time, for reasons of personal safety. Although there are similarities in how the two groups perceive gender and personal safety, there is an apparent difference in the cautious approach of the commuter, in contrast with the one-off ride-sharers.

5.4.2. In-person interactions

P2P car sharers similarly had discussions around the idea of "*gut instincts*" and building trust with potential users. Some personal providers shared the opinion that talking with a potential match beforehand is a way to "*get a sense"* of a person and can help to build trust. However, other personal providers disagree. Some have installed automatic, keyless unlock systems, meaning that all requests are automatically approved, and the renter can access the car without ever having to meet or talk to the provider (or anyone else) for the transfer of key. Interestingly, a renter who was in the focus group stated that he was wary of providers who did not want to meet face to face, *"I've always found it a bit shady when people don't want to do it in person …it's getting to know that person a little bit more, and it's a lot easier to do that in person than it is digitally*". This highlights the fact that, while a provider is the peer-party allowing a stranger to use their car, there are still *trust in person* concerns on the part of the renter.

None of the fleet providers had cancelled or not gone through with a rental on the basis of gut instincts, although some had had experiences which caused them to question a peer-users' *integrity* and *benevolence*. Some of the participants shared instances where they suspected the renters had been involved in county lines drug trafficking, and suggested that using P2P, or B2C, shared vehicles is a method of evading detection. However, in situations when the fleet providers suspected that the car might be used for these purposes, they completed the rental regardless, "*I don't care what the car is used for … bring it back clean, don't wreck it … and then do what you want with it*". One participant shared that they had black boxes fitted in their cars, so were able to know the exact journeys being made, and it became apparent to the provider that his "higher-end car" was being used for "*joyriding*" and "*as a show car*". However, in contrast to a personal provider who had worries their car

might be used for joyriding and so didn't rent it, the fleet provider didn't mind, again as long as the car was returned in good condition. This demonstrates that trust in a person's *ability* is the most important for fleet-providers, whereas trust in a person's *ability, integrity, and benevolence* are important for personal providers.

Some P2P ride-sharing commuters cited aspects of their personality and how they perceive themselves as reasons why they would be happy to share with people they did not previously know. *"I'm sociable and happy to meet new people", "yes, they say a stranger is only a stranger until you've met them … you can forge relationships quite quickly in the context of sharing space"*. Interestingly, when discussing the prospect of sharing with previously unknown people in one of the commuters focus groups, those who maintained they would be comfortable with it all agreed that they perceived themselves to be "*risk-takers*". The fact that sharing with a stranger is conflated with "risk-taking" behaviour indicates that, although these commuters said they would be comfortable with it, there is still an element of risk, or danger, which they perceive.

Another aspect of trust related with meeting others is the concept of compatibility. In the context of P2P ride sharing, this was particularly important for commuters compared to one-off ride sharers and could be attributed to the fact that commuters regularly share with the same person, or group of people. Therefore, all participants agreed that it was important to get on with, and be comfortable around, the people they ride share with, "*That brings me to my basic rule of car share, we only have one rule and that's what goes in car share stays in car share. Joking aside, that kind of makes it special really, because it is that unwinding at the end of the day, swearing at your car share partner and having that bitch fest. It does help, and it helps to have that confidence in place that that person is sharing that with your privately and it won't go anywhere else. That's helpful for your wellbeing I think in a little way."* This quote illustrates the trust in the confidentiality of the participants sharing group, as well as the social benefits derived from sharing. Conversely, some participants shared negative experiences of sharing with others, based on perceived personality incompatibilities. In all of the examples that participants shared where there were personality incompatibilities, those sharing groups had since disbanded. However, although this does highlight the importance of compatibility, it is not necessarily a direct comparison with trust. It is possible to trust someone but have poor-quality in-person interactions.

5.4.3. Driving quality

The concept of personal safety was a main concern for the one-off ride-sharers, and one manifestation of this is the driving quality of the peer-provider (i.e., driver). Some participants shared experiences where the drivers had been drinking alcohol and smoking marijuana while driving. These instances are examples of threats to personal safety due to the driver's condition at that time (thus their *ability* to complete the transaction safely). It is interesting to note that none of the participants who had experienced this raised it with the driver or stopped the journey early. When discussing why, there was a general agreement that doing so could leave the participant in a "vulnerable" position away from their intended destination. In these cases, it was seen as a "needs-must" to get to where they wanted to go. As one participant put it, "*I think sometimes you can get tied into something and you don't realise in the beginning what that person might do while they're driving*".

Driving quality was equally a main concern for providers of P2P car sharing, albeit from a different perspective. While ride-sharers concerns about driving quality centre on their personal safety, providers of P2P car sharing are concerned about driving quality and the potential implications this has for the condition of their vehicle. However, among the P2P car share providers there were key differences between fleet providers and personal providers. Overall, personal providers are more wary about who they rent their car to, and the potential consequences of renting out their vehicle than are fleet providers, *"That's my car, and I want you to take good care of it and return it so that I can continue to use because it is my car".* Trusting a person to "*take good care of it*" could be an expression of all three dimensions of trust; their *ability* to drive it in an appropriate manner, their *benevolence* in that they are well-meaning with their intentions regarding the car, and their *integrity* and keeping their word that they will take care of the car. All of the personal providers who participated in the focus groups had had experiences with renters who had caused damage to the car (one participant's car had been written off) or had incurred fines during the rental (from parking tickets and driving in bus lanes).

While many of the fleet providers had experienced the same inconveniences from their rentals the personal and emotional impacts are lessened. Fleet providers agreed that they would not rent out their personal cars on the platform, given the potential for things to go wrong. "*I don't think you can [rent it] if you see it as your personal car …so people who have attachment to their cars, or depend on them for work where they can't break down, they don't last very long [on the platform]", "Yes, personally I did once have a personal car on a*

platform, but I didn't ever rent out my personal car, because I was just worried every single time that someone requested it, I'm going to earn 60 quid from this but what if they stuff it into a wall and there's more costs". This illustrates the emotional distance fleet providers have from their vehicles (and which they deem to be necessary), and the notion that the risks for renting a personal car are too high. This demonstrates what Valor (2020) refers to as "anticipated stress" and is identified as a barrier to the continued adoption of P2P car sharing for peer-providers. One fleet provider shared an experience of a renter crashing their car, *"Someone properly crashed one of my cars … but the platform just fixed it all, gave it straight back to me, Bob's your uncle. Made loads more money, and now I'm about to sell it. It's just a piece of metal to me, that makes me money*". This quote demonstrates both the emotional distance they have and the financial motivations to be a fleet provider on this platform. This opinion is also a clear contradiction to the opinion of the personal providers.

In a similar vein, the condition of the car was an important consideration for one-off ride sharers. One commuter shared an experience of the wing mirror of the car they were travelling in with a colleague being held on with tape, *"we were sort of like, "I'm not sure if that's legal" because it looked like it was going to fly off and hit the car behind us at any point, and we were all sort of feeling really uncomfortable* … ". This demonstrates how the feeling of personal safety transcends just trusting in person, and it is also vital to have trust in the safety of the vehicle in which you're travelling (*trust in product)*. Similarly, most one-off ride-sharers agreed that they would not continue a journey if a car was in bad condition, although when further probed none had ever cancelled or terminated a journey for this reason. This could be testament to the fact that typically the quality of the vehicles is sufficient and could also raise important questions about the "self-regulating" aspects of the platforms; those with inadequate cars would be more likely to have journeys cancelled or to be reported, therefore they are less likely to still be active on the platforms. Commuters may be more likely to experience issues in this area given the more informal nature of some of the shares (i.e., not being listed on a platform anymore) and the more collegial nature of the relationships between commuters.

Peer-service users of P2P car sharing also need to trust in the quality and safety of the vehicles they are renting. During the focus groups, little emerged from the discussions which explored this concept exclusively, instead most discussions addressed trusting in the person and trusting in the platform (rather than the product of the car itself). This could be due to the fact that all of the platforms have strict requirements for the quality and condition of the cars which they list. Therefore, trusting in the platform to uphold these requirements could

explain the lack of explicit concerns about the condition of the vehicles. Similarly, as all the peer-providers agreed on the importance of reviews, it could be that peer-providers with negative reviews concerning the condition of their cars were removed from the platform. Peer-providers all shared the opinion that it is important to give renters a good experience (thus demonstrating *integrity*). This demonstrates how the three dimensions of trust in person, platform, and product interact.

5.4.4. Reviews and ratings

Reviews and rating systems are used by platforms as a means to build trust between platform-users (ter Huurne *et al*., 2017). However, there was consensus among the P2P ride sharing commuters that the reliability of reviews may be questionable. This could be because of the repeated nature of using P2P ride sharing for commuting, and the relationships that are built between people. A person may be less likely to leave a negative review for someone they have, or have had, repeated contact with. One participant stated that they would not leave an honest review of a prior match who was "*a terrible driver*", because they did not want to ruin their chances of finding future matches. None of the commuters place much importance on a potential matches reviews, although given the concerns about the reliability of reviews this could perhaps be expected. Similarly, for those who share with people from the same workplace, other mechanisms of building connection and trust appear to be more important than reviews. Indeed, most of the commuters who use a workplace specific version of a ride sharing platform do not have the option of leaving reviews for their matches.

Similar to the commuters, some one-off ride-sharers agreed that reviews of other users visible online might not be reliable. Of the participants who frequently left reviews following a journey, all agreed that their default would be to leave "*5 stars*". One participant stated that they had only ever left one 4-star review, and this was due to "*aggressive driving style*", with another adding, "*yeah, it would take a very bad experience for me to leave anything less than 4 stars. It would have to be really bad*". Previous research has also identified that reviews and ratings on P2P platforms tend to be inflated (Zervas, 2021). This draws into question the reliability and validity of peer-review systems as a digital mechanism to facilitate trust.

Perhaps understandably given the increased likelihood of sharing with strangers, one-off ride-sharers overall place a higher value on reviews and ratings than did the commuters, although there was disagreement among the groups as to exactly how important these are.

On the one hand, a minority of participants viewed reviews as being "*really, really vital*", and playing a large role in someone's decision when searching for matches. However, the majority of participants shared the opinion that reviews were not that important. There were several reasons put forward as to why this is the case, but the overall consensus among this group was that, while it is sometimes "*nice*" to see reviews, it isn't "*make or break*". Some participants disregarded reviews if they found a match that worked with their schedule. Further, as discussed above, the integrity of reviews was drawn into question too. Some of the participants had experience using platforms that do not have an explicit rating system in place, and instead operate as more of a message board. This could perhaps explain why some participants do not place a high importance on reviews. However, these platforms do enable people to leave comments below the original request/offer for a lift, and as such could be thought of as somewhat of a proxy for an official review and rating system. Some participants stated that they take time to read the comments below a potential matches previous posts, with a view to see if there are any negative comments or reviews.

For those participants who did look for and take reviews into consideration, there was an agreement that negative reviews hold more weight than positive reviews. Given that participants are unlikely to leave a negative review unless a journey was "*really bad*", it follows that people place more significance on a negative review or comment. As one participant put it, "*no reviews are better than bad reviews*", to which another participant responded "*yeah, reviews are only important if they have a bad one*". Finally, some participants felt reassured that, if a person was still active on the platform, it meant that they had not been reported or removed for any negative reasons. In this instance, the platform could be thought of as somewhat of a self-regulating system, where the continued presence of a person on the platform creates the impression that this person is trustworthy, in particular regarding their *integrity*.

From the perspective of a P2P car-sharing provider, there are clear differences between how personal providers and fleet providers view the importance of reviews, which echo the different perceptions towards trusting potential users. Personal providers agreed that they spent time reviewing the profiles of potential renters and were suspicious of certain characteristics of potential renters. Participants discussed being wary of, and in some cases rejecting requests from: those who were younger (questioning their *ability*); those who had no, or low, reviews from previous rentals ""*if someone had a string of bad [reviews] that's reassurance for me that that's not somebody I want to rent my car to"*; and situations which "*just felt a bit odd"*, related to concerns about joyriding (questioning their *integrity* and

benevolence). There was agreement that those with higher ratings and reviews tend to get more rentals, from both the perspective of providers and users. This can be interpreted as both providers and users preferring to match with others with experience of the platforms. However, this stance provoked an emotional reaction from a renter, who questioned how renters were supposed to get a review or a rating in the first place if providers took this into account "*It's frustrating as a user to hear those other comments around if people only go on your ratings, that's really difficult to hear"*. In response, some providers reaffirmed that no rating was seen as better than a negative rating, and some agreed that they would never reject someone on the basis that it was their first-time renting. Some participants felt that the nascent nature of P2P car sharing combined with the fact that most renters use P2P car sharing on an infrequent basis meant that most people did not have multiple reviews. This renders reviews a useless metric, *"…I don't feel it's something you can use, at least at the moment, to make any decisions. I feel like it's not very useful at the moment until there's more ratings*".

Interestingly, the notion of P2P car sharing platforms being a "self-regulating" system, in terms of trusting other users, was raised in both focus groups (and indeed with one-off ride sharers focus groups too). The personal providers arrived at the consensus that the platforms were self-regulating in the sense that it "rewarded" peer-providers who were more willing to take a risk with renters with no reviews, and therefore more likely to stay on the platform. Given that there were few potential peer-users on the platform with previous reviews (owing to the relative nascency of P2P car sharing in the UK), in order to complete rentals personal providers were encouraged to accept renters with no reviews, and in doing so would get an additional rating. Similarly, there was unanimous agreement that having reviews and ratings as a peer-provider was viewed as pivotal to securing future rentals, *"Reviews are the most important thing …", "Yes, I think you can get hammered if you only have a few reviews"*. All of the participants shared the opinion that renters tend to choose the most popular providers, and agreed that those with multiple cars, which are always available to be booked and thus provide greater functionality, would be seen as much more attractive to potential renters than personal providers, who tend to only have one car available for booking at weekends. This fact could explain why the personal providers struggled to secure the demand and reinforces the notion of needing to take initial risks with regards to vetting potential renters, in order to build the strength of their profiles.

The fleet providers of P2P car-sharing agreed that the system was self-regulating in the sense that, if a renter had an average star rating of below 3, they were banned from the platform,

"guest reviews are almost irrelevant, if it's that bad [the platform] will kick them off". For some fleet providers, this was the assurance that they needed, in lieu of a personal rating or review. This is an action taken on behalf of the platform which can lead to trust in person. One of the fleet providers shared his experience of renters being removed from the platform, *"I've had a couple of people kicked off the platform, like someone who just left loads of weed and mud and everything, and left the doors open and just crashed it into a wall and just left the car … whatever, I made some money out of that as well.*" This quote further illustrates the emotional detachment fleet hosts have to their cars, and how, despite this negative experience, the provider framed it in such a way to be more about their financial gains, rather than the inconvenience from, or emotional response to, the events.

Given the high importance that all adopter groups place on driving quality, it may be more appropriate for platforms to rethink framing their reviews and ratings to focus on a person's ability. This dimension of trust encompasses driving quality (ability of someone to complete their part of the transaction safely) and was deemed the most important for all adopter groups.

Finally, it is interesting to note that all the fleet-providers had started using P2P car sharing on the recommendation of others within their social networks, who were already using P2P car sharing as a peer-provider. This is a demonstration of the importance of trusted others in an individual's decision to adopt an innovation, in line with DOI.

5.4.5. Reputation of the platform

One manifestation of trust in a platform can be how its users perceive, and place value on, its reputation (Ter Huurne *et al*., 2017). From a P2P ride-sharers perspective there was consensus among both the commuters and the one-off ride sharers that the reputation of the platform was of low importance. However, there were different reasons why for the two groups. For commuters who shared with people they previously knew, or people from the same workplace, the decision to choose which platform to use is taken out of their hands. To this end however, some participants who used workplace-specific version of the platform did state the importance that their workplace collaborate with "*a reputable company*", *"What's important is it's not seen as a fly-by-night set-up, you know it's not ... they haven't engaged with somebody who just created a bit of technology and set it up in something like 5 weeks*". Although the commuters did not have a say in which platform their workplace decided to partner with, some did have an opinion on the reputation of the platform, which could still have acted as a driver or a barrier to them choosing to participate in the workplace

scheme. Furthermore, some participants automatically trusted the platform, given that their workplace had chosen it, "*I think it gained its reputation from my workplace … I trusted my organisation so therefore I used it*". This demonstrates the importance of trusted information sources in a person's decision to adopt P2P mobility. In this case, the trusted information source is the person's workplace.

The size of the user-base of a platform was also a key consideration for providers of P2P car sharing, rather than the reputation itself. All of the fleet providers agreed that, given that the platform they use currently has the largest, and most established, user-base in the UK, they were acting as a sort of "*monopoly*". Fleet providers felt that this enabled them to increase their fees and change the details of various terms and conditions, as they were not aware of any viable competitors on the market. In addition, as part of the platforms' conditions providers are not permitted to list their vehicle on any other platform. This reinforces the notion that the platform is monopolising the market. However, all the fleet providers were still using this same platform, and thus contributing to its growth, *"[Platform] prohibit you from sharing on other platforms, so it was like a year or 2 ago they said you have to be exclusive to us, and that obviously has implications for us, so for me although it is a negative thing it is a draw towards [platform], they've got the guests, they've got exclusivity so we have to be listed to them, so it's sort of a virtuous circle for them".* The fact that this platform has the largest user base, and therefore the *ability* to find renters for these providers, explains why these providers are still using this particular platform. In addition, this is another example of how the reputation, in this case in the form of its dealings with hosts, could be seen as less important than the ability to match providers with renters.

Among P2P car-sharers, both personal providers and fleet providers discussed how the fact that the platforms they used were paired with mainstream insurance companies helped to build trust in the platform, in the form of *integrity*. This gave credibility to the platform, and reassured providers, both fleet and personal, that any issues would be handled professionally. Indeed, most of the personal providers and fleet providers who had had to make a claim praised the platforms processes. "*There's been some scratches on a roof before on one of my cars, how do you get scratches on a roof I've no idea. And I just showed them some pictures and the light was shining on it and it was really hard to see the scratches and the platform just paid out straight away to be fair. It wasn't a big bill but they just paid straight out and it was absolutely fine*". This could also be an example of the *ability* of the platform to resolve any potential issues, again helping users to trust the platform. However, some participants did share more negative experiences when dealing with the insurance and

compensation aspects of the platform, "*for people getting tickets, speeding fines and stuff like that there wasn't any like compensation for me having to deal with that, which I found was really annoying*". Providers could see this as a negligence of *benevolence* on the part of the platform. Although the platform did cover the cost of the tickets and fines, the provider still had to deal with the stress of the situation.

Furthermore, even though participants agreed that the platform had covered any damage costs, there were criticisms of the platform's financing model. All fleet providers agreed the costs and charges to both providers and renters were "*extortionate*", "*I think the platform on the whole are too greedy, I think they're charging way too much, obscene amounts to be honest to both guests and hosts*". Participants discussed the recent changes to the protection plan, which now state that for providers with the lower level of protection, there is now an excess of £350 for insurance claims. All the participants agreed that this was a manifestation of greed on the part of the platform, "*it is ridiculous, because ... we're not driving it, we are their business, without us they don't have a business, they should be looking after us ... we should be gods to them in reality*". This quote demonstrates the apparent frustration providers have with the way the platform has dealt with the rise in insurance excess, which is also a demonstration of a lack of *integrity* and *benevolence*. Other participants also commented on the integrity of the platform, "*They're arrogant, they're really arrogant…they don't value their hosts", "Yes, very American company…it's like they don't tell you anything, they don't consider you as an individual you're just customers, and they just execute without consideration. And it's like smoke and mirrors for a lot of things".* This exchange illustrates frustration with the way that the platform operate and is a further example of the apparent antagonistic relationship between the platform and the providers. Providers feeling unvalued, and not considered further demonstrates strained trust between the provider and the platform, in the form of *integrity* and *benevolence*.

Finally, some P2P car sharers had concerns over how their data were being collected and managed by the platform. One participant described how, when he was searching for a platform, having a transparent data protection policy was important. P2P car sharing platforms ask for, and store, driver's license details, residential addresses, and passport photos. Participants agreed that the onus was on the platforms to demonstrate their trustworthiness regarding personal data. This was heightened given that some P2P car sharing platforms had ceased operations, *"some people had mentioned that these platforms just seem to disappear overnight, and they've actually got your data as they go so it's a bit*

worrying at times". Handling and storing participants' data in a trustworthy way is a manifestation of a platform acting with *integrity* and *benevolence*.

5.4.6. Finding matches

Almost all the P2P car sharing providers based outside of London had had issues with there not being enough demand in renting their cars, which led some to feel that they do not mind who is renting the car, so long as it is rented. Instead, these providers trust in the platform being on hand to sort out any potential issues *"I'm much more attracted to the fact that they have a mainstream insurance company, who have accepted their premiums in order to provide their insurance*". This was the general opinion of the fleet providers too, that the ratings or reviews of an individual are not important, given that the insurance companies are able to deal with any potential issues that arise from the rental. This illustrates the contrast in perspectives between fleet providers and some personal providers, and the other personal providers who had higher emotional attachment, and more reliance on their cars.

Both personal providers and fleet providers have concerns regarding trusting the platforms they used; however, these tend to manifest in different ways. As previously mentioned, the personal providers based outside of London agreed that they had had trouble in securing matches. One participant shared their observations that the platform they were using were no longer advertising outside of London. This draws into question the *ability* of the platform to find matches for providers and renters. In a similar vein, the fleet providers discussed the *ability* of a platform to find matches, but these discussions centred on the use of the platform's algorithms, "*You don't want to decline trips because the platform, or the algorithm, certainly does punish you for that, so it's quite difficult*". Here, fleet providers are aware that their ability to continue securing matches on the platform relies on their acceptance of previous matches. This could explain why some of the personal providers were having issues securing matches. As explored, personal providers were more likely to review a potential renter's profile before accepting a match. If a personal provider repeatedly turns down potential matches, it could impact how the algorithms allocate them future potential matches.

The importance of securing matches was a main concern for one-off users of P2P ride-sharers too. Most participants agreed that the reputation of a platform was not an important factor in the decision to use one platform over another, and instead it was the *ability* of the platform to find a match which was of most importance. Some participants posted requests on multiple platforms in a way of "*hedging bets*". There was consensus among the

participants that larger platforms felt safer, given the higher number of people using it "*For me, it's not so much the platform that matters, like not the reputation; it's how big it is. For me to trust a website …I would have to see that there was a lot of people using it before I would start using it to find lifts".* This quote appears to combine the disregard of a platform's reputation, and places emphasis on building trust in a platform based on the experiences of others. Here, trust could be thought of as in a "*herd mentality*" sort of way; if many people are using a platform, it must be safe. Similarly, participants reiterated the self-regulating nature of the platform, in that if a member had repeated negative experiences, they would be removed. This was another feature of the platform that built trust, in the form of *benevolence*.

5.4.7. Reliability

Most of the concerns raised by P2P ride-sharing commuters regarding trust in person relate to the idea that a potential match may not be reliable. Many participants agreed that prior to starting using P2P ride sharing, they worried about matches being late, changing home-time plans partway through the day, and being unreliable, especially if their match was driving (*integrity*). These concerns reiterate the inherent lack of autonomy involved in P2P ride sharing. While some participants had "uneventful" matches and experiences commuting with others, there were numerous who had encountered difficulties relating to others' reliability. As one participant put it, "*not everyone is going to be reliable and there may be teething issues*". All participants agreed that it was vital to be transparent in this regard. Some participants expressed that they are unable to be flexible at all regarding the return journey after work, given family and home commitments. For others, this was less of a consideration, "*…we can catch the bus if necessary so we can get over it*". In a similar vein, some commuters expressed frustration that potential matches were not always "forthcoming" about their working schedule, and thus were seen as "*a massive waste of time*". This draws into question the ability of potential matches to successfully form part of a reliable commuting group. Of the participants who had had trouble with reliability, some solved these through communication and changing driver/passenger schedules, "*the other people are a little bit younger than me, so they tended to go out for some drinks after work, so it suited me to be the one who had the car … it worked better for me as a driver*". Others no longer shared with that person, "*the other person just catches the train now because he's not flexible at all*". Given that all participants in the focus groups were current users of P2P ride sharing, none of them had stopped commuting with others completely based on these issues with reliability. However, it is possible that this could be the case for some people.

One-off ride sharers shared similar concerns over reliability, and numerous participants expressed experiences when potential matches had fallen through, or they had been "let down" at the last minute. The uncertainty and, in some participants' words, "unreliability", appear to be part of the nature of P2P ride sharing. Most participants agreed that even after a match had been confirmed, they were still actively looking for back-up, or "just in case" methods of transport, pre-empting that the journey might fall through. One participant shared an experience when the lift cancelled on them on the day, and they did not have enough money to take the train; "*I feel like I was left in quite a precarious position … I feel like I've relied too heavily on them to get me where I need to go*". The low cost of P2P ride sharing in comparison to public transport or alternatives was a main motivator for all participants (see previous chapter). It is understandable therefore that a lack of reliability on the part of potential matches can put one-off ride-sharers in a potentially difficult position.

In the framing of *ability*, *integrity*, and *benevolence*, the possibility of being let down before completing a journey was seen by some participants as relating more to a person's *ability*, especially in instances when journey times or plans changed. However, the ways in which many participants spoke about these experiences suggest they imply a person's *integrity* and *benevolence*. Almost all participants had experienced potential matches who stopped responding to messages, and this appeared to be a universal source of frustration for one-off ride-sharers. This behaviour showed "*a lack of common courtesy*" and was regarded as "*a main inconvenience*" of using P2P ride sharing.

The concept of reliability was not discussed in the focus groups with P2P car-sharers. None of the providers shared any experiences with renters not turning up, and similarly none of the renters had had issues with the reliability of providers. It could be hypothesised that these issues were neither as common, nor as much as a concern, for P2P car-sharers than P2P ride-sharers due to the role of the platform as intermediary. In the case of P2P car-sharing, bookings and payments are managed by the platform itself, whereas in the case of P2P ride sharing, the platform acts as more of an intermediary to match drivers and passengers, and then arrangements and payments are made direct between the two parties (often cash is paid during the journey itself, not in advance). Therefore, the scope for reliability concerns is much reduced in the case of P2P car-sharing.

5.4.8. Summary

Figure 8 summarises the key findings from this section in a table.

	Relative importance of the aspects of trust ✓✓ Very important ✓ Important ✗ Not important					
Adopter group	Personal safety	Interactions with others	Driving quality	Reviews and ratings	Reputation of the platform	Finding matches
Commuters	✓	✓✓	✓✓	✗	✗	✓✓
One-off users	✓✓	✓	✓✓	✓	✗	✓✓
Peer-providers	✗	✗	✓✓	✓	✓	✓✓
Peer-users	✗	✓	✗	✗	✗	✓

Figure 8: A summary of the key findings of the importance of trust for each adopter profile.

5.5. Results and analysis: Perceptions of trust in COVID times

All of the focus groups were conducted during the summer and autumn of 2020. At this time the UK was under varying levels of COVID-19 restrictions. None of the P2P ride sharers (nether one-off sharers nor commuters) were using P2P ride sharing at the time of the focus groups. This was due to numerous factors. Most of the commuters were working from home at the time of their focus group and travelling into their workplace was not an option. Two participants who were able to travel into their workplace at the time of the focus groups said their employer forbade ride sharing at the moment, given concerns over the lack of social distancing it inherently entails, "*so after years and years of them saying we must car share we must car share, they've turned around and said no we must not car share*". In these instances, the decision whether to ride share or not was made on behalf of the participant. However, most participants were in agreement that they would be hesitant about commuting into work with others again, against the backdrop of COVID-19, *"…you don't know their medical history and they're sitting in a car with you and they're really close", "Yeah, You don't really want to be in confined space with someone who you don't know their situation, you don't know where they've been … And you can't really ask those kinds of questions to people all the time".* It is interesting to note that commuters, who share with the same groups of people consistently, are perceiving the possibility of sharing in the future in this way. Therefore, it could be expected that one-off ride sharers, given that they share

journeys with different people each time, would share the same hesitations, if not stronger. However, this was not really the case. The reason for this difference could be due to the alternatives. For commuters, the most obvious alternative, especially at the time that the focus groups were conducted, was to work from home. In this instance, the alternative is believed to be "risk-free". On the other hand, one-off users perceive public transport to be their alternative, and most participants agreed that they would rather ride share with one other person, than take public transport, *"I am terrified of going on the train or the coach or whatever because I will be sharing with 30 plus people … also having to get to these high points of people going through big stations in London … I think that I would feel safer getting into a car with one other person …I'd rather find a way to make that work than put myself on a train where I might be sardined in with however many people*". This sentiment was shared by most of the participants.

However, there was a minority of one-off ride sharers, in both focus groups, who would not feel comfortable sharing a journey given the situation with COVID-19. For these participants, there was no alternative method of transport, instead they would not make the journey at all. As mentioned, all of the one-off sharers did so in the capacity of a passenger. It would be interesting to have had the perspective of peer-providers (drivers), to be able to compare how they would feel at sharing their vehicle and their journey. From a driver's perspective, the alternative to a shared journey is a sole journey, given that they have the ability to make a journey regardless of the presence or absence of passengers. If passengers have hesitations about sharing, it could be expected that this would be stronger for drivers. None of the participants had actually used P2P ride sharing since the start of COVID-19 restrictions, so had no experiences of whether or not it was more difficult to find matches. However, most platforms paused operation during the COVID-19 lockdowns. This, combined with the expected reticence of drivers to share their journeys, leads to the expectation that, as well as there being much reduced demand, there is equally much reduced supply.

In the case of P2P car sharing, there were distinct differences among the participants. There was a shared perspective among some personal-providers, and some peer-users, that they would expect the car to be thoroughly cleaned in between rentals. However, owners agreed that this would be an onerous task, and would entail a degree of responsibility some owners were not happy to accept. Furthermore, given that they also make use of their personal cars, some owners felt the element of risk of letting strangers rent it out was too high, and have therefore temporarily removed it from the platform. One personal provider mentioned that he "*didn't want to put [his] family at risk, the risk is just too high*". Interestingly, none of the

fleet providers mentioned cleaning or disinfecting their vehicles between rentals, whereas this was a big concern for personal providers. This could possibly be explained by the "professionalisation" of some fleet hosts. These fleet-providers do not use the vehicles which they offer on platforms as their personal vehicles, and so it can be suggested that they do not perceive the same risks to themselves as the personal providers do. This difference in perception to risk to self could perhaps explain this observed difference.

From the different peer-perspective, some peer-users agreed that they would feel uncomfortable renting a vehicle through P2P car share and trusting that it had been properly cleaned before the rental and would trust a B2C provider more than an individual in this case. "*The risk one reason I'm just not using P2P car sharing at the moment and am doing car hire, because theoretically the consistency between … you know if you go to Enterprise*[8] *theoretically the consistency between all their places cleaning cars should be good, and you know if you've got a reputation like that to uphold then you better make sure it's good*". This demonstrates how the lack of regulation and potentials for inconsistencies in P2P business models can lead to reduced trust, when compared to B2C alternatives.

All the fleet providers agreed that, after an initial shock in March and April 2020, demand for their vehicles was at the highest levels they had ever experienced (and all fleet providers were still active on the platforms). The general consensus was that this increased demand is due to peer-users not wanting to take public transport and so using P2P car sharing as an alternative, and many of these renters had no experience of using P2P car sharing before COVID-19. This positions peer-users in an interesting place concerning alternative methods of transport. It appears that, for some peer-users including those who participated in the focus group, the main alternative to P2P car sharing is B2C car rental and given COVID-19 this group has more trust in B2C car rental. However, there is a second group of peer-users, who view P2P car sharing as a more attractive alternative to public transport.

5.6. Discussion

This chapter explored the role of trust in the adoption of P2P mobility innovations using the research model proposed by Hawlitschek, Teubner, and Weinhardt (2016) as a framework. This model enabled trust to be framed and explored fully (from the different perspectives of peer-providers and peer-users, recognising the different targets of trust, and recognising the different dimensions of trust).

[8] B2C car rental company

The focus group discussions took numerous directions and explored a range of factors which influence participants' propensity to trust others. Participants also discussed their concerns with regard to trusting others, framed as what they thought could be the consequences of using P2P mobility innovations. The actions that a platform can take to alleviate some of these concerns, both those that they actually do, and hypothetically, were also explored by participants. Understanding the range of factors that influence trust is vital to understanding the adoption and use of P2P mobility innovations. This is necessary to being able to estimate their diffusion potential. There are numerous contextual factors, decisions, and choices and uncertainties involved in someone's decision to use, and continue using, P2P mobility innovations.

Figure 9 shows how all the concepts relating to trust map on to the theoretical framework for P2P mobility adopters in general. This diagram synthesises the separate peer-perspectives and separate innovations and provides an overview of the nodes which influence the dimensions of trust and the objects of trust in the context of P2P mobility. The dimensions of difference will be drawn upon to structure this discussion section.

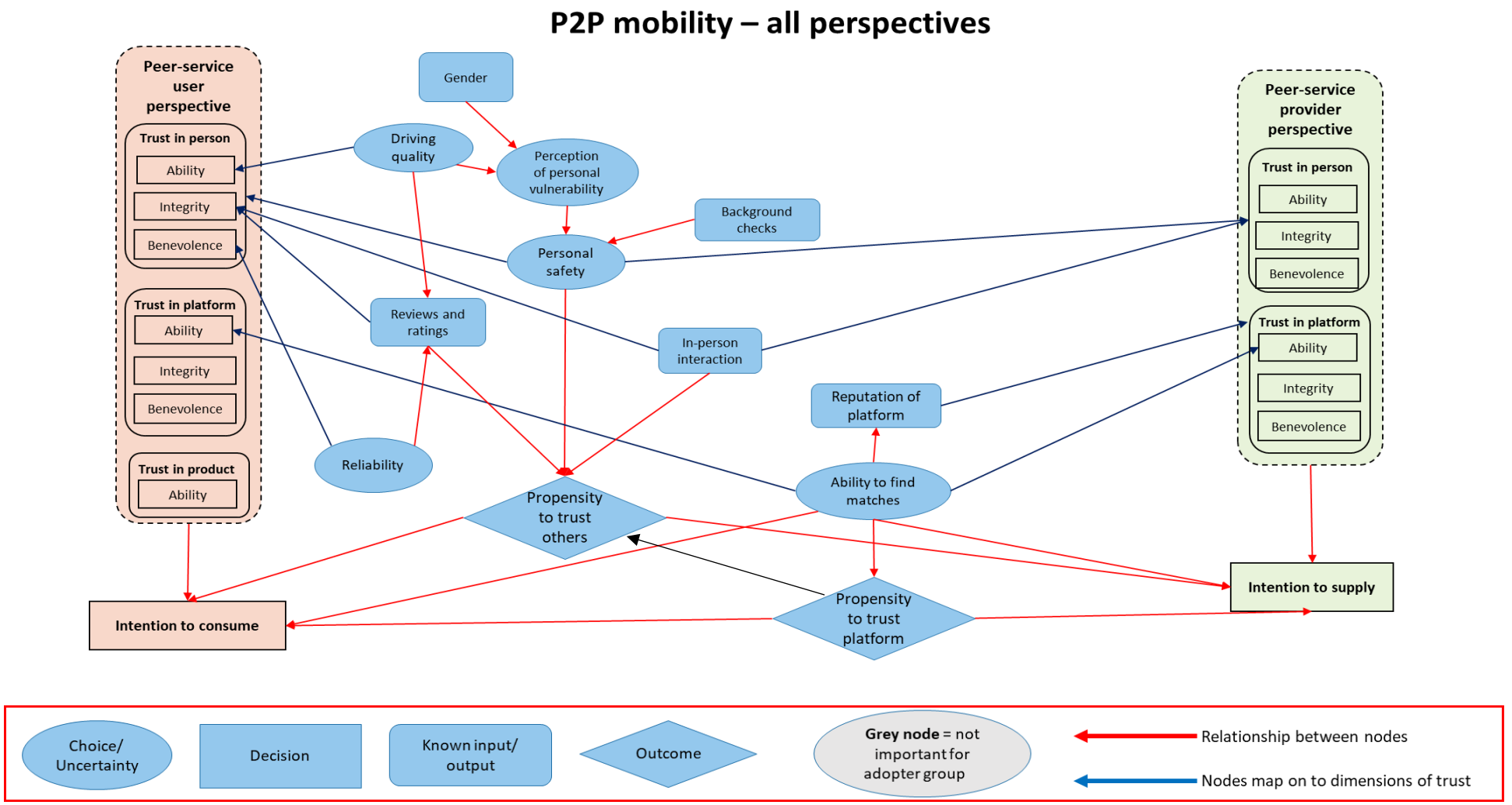

Figure 9: An influence diagram combining the results from all the adopter groups.

The reputation of the platform is not a main consideration for adopters. This finding goes against what was hypothesised. However, the integrity of the platform emerged as key. This demonstrates that while the reputation of the specific platform was unimportant, adopters had expectations about the levels of integrity and benevolence (and to an extent the ability) of the platforms they use. However, it could also be argued that while adopters state that they do not perceive the reputation of a platform to be important, the integrity and benevolence of a platform is a manifestation of it's reputation.

Trust in product did not emerge as a dimension of trust. This dimension is only relevant to potential peer-users and not peer-providers. Furthermore, the "product" is different for the two innovations. For P2P ride sharers, the product being offered is a journey as a passenger. As discussed in Chapter 1 this is considered a service. While trust in the product was not a consideration for P2P ride sharers, driving quality was a factor which impacted trust. Therefore, for P2P ride sharers the trust framework could consider trust in product as a subset of trust in person, specifically the ability of others to provide the service safely. For P2P car sharers, the product being offered is the vehicle. This could be explained by P2P car sharing platforms' regulations concerning the required condition, age, and upkeep of vehicles listed on their platforms. That P2P car sharers had no concerns could suggest that the current mechanisms undertaken by platforms to ensure vehicle quality are sufficient.

Reviews and ratings are not generally considered an important trust-building mechanism by adopters. While reviews and ratings are proposed in some literature as a key means to facilitate digital trust between peers (see Amirkiaee and Evangelopoulos, 2018; ter Huurne *et al*., 2017), other authors argue that the emphasis placed on digital reputation systems is unfounded. There is an apparent skew towards positive reviews and ratings (Stemler, 2017; Zervas *et al*., 2021). This draws into question the reliability of reviews and ratings on P2P platforms. The results from this chapter support this notion that there is an apparent inflation of reviews and ratings. In particular, participants in the one-off users focus groups stated that they had never left a review below 5 stars (the maximum), despite having had some negative and dangerous experiences.

This raises the question of how interpersonal trust is communicated among peers, if not through reviews and ratings as digital reputation systems. The findings from this chapter suggest two main mechanisms to this end. First, the importance of in-person interactions emerged in most adopter groups. Social interactions between peers facilitated trust building. For commuters, having repeated journeys with the same group of people was vital

to their perceptions of trust in other users. Second, adopters trust in the platform could be regarded as a "proxy" for trust in other users. Most providers of P2P car sharing agreed that the reviews and ratings of potential peer-users were unimportant, and this group tended to trust that the platform would have the ability and the benevolence to rectify any issues which could arise with their vehicles. This finding supports Mohlmann's (2016) suggestion that trust in the context of the sharing economy is a "two-fold" construct.

Adopters of P2P mobility regard the platforms as "self-regulating". This "self-regulation" reassures adopters that the other users of the platform are trustworthy and creates a sense of community vetting. While reviews and ratings of other users were not a main consideration for most adopters, there is trust in the process that untrustworthy people will be removed from the platform. In this case, the requirements of trust in person are incorporated, and provided by trust in the platform. In other words, adopters trust in the platform provides trust in the other users. This relationship between trust in the platform and trust in other users is emphasised in Figure 9 by a black arrow. This finding is a further demonstration of the hypothesis by Mohlmann (2016), that trust in P2P platforms is a "two-fold" and hierarchical construct. Trust in the platform is a mediator of trust in person. This was evidenced in this chapter through respondents perceiving the platform as "self-regulating" and trusting in the institutional security provided by the platform. This further demonstrates how vital it is that platforms demonstrate integrity and benevolence.

However, the "self-regulating" mechanism is dependent on other users of the platform reporting individuals who have displayed inappropriate behaviour. Therefore, adopters are also expressing trust in person, trusting that other users will hold each other accountable to the platforms' community standards. The "self-regulating" mechanism can therefore be regarded as a cycle of trust in person (to report other users), creating trust in platform (for setting and upholding community standards), thus resulting in trust in person during P2P interactions.

Gender influences perceived personal safety. This result emerged during the focus groups with P2P ride sharers. A limitation of this research was that there was only one woman participant across the P2P car sharing focus groups, meaning that there may be further dimensions that gender influences in the context of P2P car sharing which may not have emerged during the focus groups. Previous research has suggested that there are fewer women who participate in P2P car sharing for numerous reasons, including women "having a lower affinity for technology than men" and the use of technology in P2P car sharing

platforms being a barrier (Alonso-Almeida, 2019). Previous research found that women adopters of P2P car sharing prefer to travel as a passenger and with people from their own social networks (Alonso-Almeida, 2019; De Luca and Di Pace, 2015). This demonstrates how gender can have a direct impact on propensity to trust others, and trust in person. Furthermore, this could be regarded as a barrier to adoption that can be difficult to overcome.

As gender impacts perceived personal safety, introducing ID verification and background checks could help alleviate some of these concerns. In the context of P2P ride sharing women feel safer (have a stronger perception of their personal safety) when travelling with other women. Encouraging more women to use P2P mobility platforms as peer-providers is likely to have a cascade effect and result in more women using these platforms as peer-users.

One of the main differences between adopters of P2P car sharing and P2P ride sharing perceptions of trust can be attributed to *what* they are trusting the other person with. Adopters of P2P ride sharers share their personal space. In the case of P2P ride sharing, especially the one-off ride sharers, discussions focussed mainly on trusting others with their personal safety. Adopters of P2P ride sharing share their personal space. On the other hand, some providers of P2P car sharing trust others with a high value and symbolic good – their personal vehicle. In contrast, fleet providers of P2P car sharing share a commercial asset with others. The distinction between these business models and the "objects" being shared represents a crucial difference in the mechanisms of developing trust.

Trust in person is the most important object of trust for P2P ride sharers, whereas trust in platform is most important for P2P car sharers. This finding supports the hypothesis stated in section 5.2. This is an important insight and could have implications for platforms. Platforms could develop specific mechanisms which facilitate trust-building; P2P ride sharing platforms could focus on facilitating trust in other users (through background checks and ID verification, sanctions for users who do not abide by platform protocols, and text-based reviews, as examples). P2P car sharing platforms could focus on developing trust in platform (through partnering with a mainstream insurer, sanctions for users who do not follow platform protocols and having formal rules of expected behaviours, and further facilitating finding matches). Furthermore, previous studies have found that having a large user-base can facilitate trust (see Mohlmann, 2016). The size of the user base is vital to ensuring sufficient demand and supply for both peer-providers and peer-users. This is supported by

the results from this chapter and the importance that all adopter groups placed on the "ability to find matches", as a dimension of trust in the platform.

Furthermore, the requirements of trust are asymmetrical: peer-users and peer-providers have different vulnerabilities and place different importance on different concepts of trust. These distinctions between peer-role can be fluid, as observed with the commuters. This finding could have potential insights for P2P mobility platforms. Specifically, this finding demonstrates the different perceptions and needs of different adopter groups, which can help platforms develop informed and appropriate marketing strategies to encourage adoption.

There may be a trend towards "professionalisation" of P2P car sharing. Half of the personal providers had recently stopped advertising their car on P2P car sharing platforms. Among those, there was consensus that the inconveniences were not worth the reward, "*it was stressful for me … I'd had enough"*. This echoes a shared observation from the fleet providers, that "*there's really little incentive for a personal car owner to put their car on …", "yeah …it's kind of pointless renting your personal car really, because the numbers don't really stack up …the amount of money you're going to make, it's probably more inconvenience than it's worth*". This could suggest an inherent flaw in the business model if personal providers are leaving the platform due to the lack of incentive to stay. A potential implication of this could result in platforms having more fleet providers than personal providers in the future. A similar trend has been observed with the P2P accommodation-sharing platform AirBnB, where an apparent "professionalization", with hosts owning multiple properties, has taken place (Dogru *et al*., 2020). At its conception, AirBnB was a platform offering travellers temporary access to spare beds and spare rooms in homes. However, over the past decade there has been a trend towards renting whole properties, which gave way to people buying properties with the sole intention of listing them on AirBnB as professional hosts. In 2020, it was estimated that 63.5% of AirBnB hosts in America had 2 or more properties listed (compared to 16% of hosts in 2015-2015) (Dogru *et al*., 2020). In the case of AirBnB, it has been argued that professional hosts operate outside of the remit of the sharing economy. Most operating definitions of the sharing economy hold central the notion of harnessing idle capacity (as defined by Frenken and Schor, 2017), whereas professional hosts are instead creating more capacity (Gyodi, 2019). If P2P car sharing platforms follow suit, professional hosts will create more capacity in the form of more cars, rather than capitalising on the idle capacity of their personal cars. If this is the case, it could

be argued that professional hosts of P2P car sharing represent a form of "micro" B2C business model, rather than true peer-to-peer.

COVID-19 has added new dimensions to trust in person and trust in product. COVID-19 could be viewed as a driver of change, which has the potential to disrupt automobility and destabilise habits (Boons, 2021). The results from this chapter demonstrate that COVID-19 has destabilised P2P mobility use habits in very different ways for the two innovations. Regarding P2P ride sharers, commuters were no longer travelling to work regularly with others, and there was consensus among the participants that they would not resume commuting by P2P ride share for a considerable amount of time. One-off users were not making longer one-off journeys. On the other hand, fleet-providers of P2P car sharing expressed an unprecedented increase in demand for their vehicles, as the car is perceived as the "safer" alternative to public transport. These different perceptions of the relative safety of using P2P mobility in the context COVID-19 stem from the different business models. P2P car sharing offers peer-users rival, sole access to a vehicle, whereas sharing space is inherent to P2P ride sharing. While on the one hand trust in person has reduced due to COVID-19, on the other hand trust in product has increased. This finding contrasts with those from a recent study of B2C car sharing adopters, finding that 38% of participants were classed as "fearful", with low perceptions about the safety of B2C car sharing and reduced use during the pandemic, and 46% were classed as "cautious", with low perceptions about the safety of car sharing and equal use during the pandemic (Alonso-Almeida, 2022). The different results found in this thesis could be explained by the different business models of P2P and B2C car sharing. P2P car sharing rentals are typically longer in duration (and often over multiple days) compared to B2C car sharing. B2C car sharing is more often used for short duration and short distance trips (Münzel *et al*., 2019; Julsrud and Farstad, 2020). B2C vehicles have more people using them in a shorter period of time compared to P2P vehicles. This could explain the difference in perceptions of personal safety with regard to COVID-19.

Looking to the future diffusion of P2P mobility, modes which allow for rival use of vehicles can be expected to become more widely used against the backdrop of COVID-19. However, it is important to consider systemic changes to mobility when considering the future impacts of trust on P2P mobility. There is not expected to be a complete return to office-based working, and hybrid working combining working from home and from the office is projected to become the "new normal" (World Economic Forum, 2022). This will directly impact the future adoption of commuting by P2P ride sharing beyond the impacts of trust. The results in this chapter show that adoption of P2P car sharing increased after the first lockdown in

the UK eased due to people wanting to have access to private vehicles to take on domestic holidays. The long-term impacts of COVID-19 on international travel and tourism remain unknown (Wassler and Fan, 2021). However, at the time of writing the perceived value proposition of P2P car sharing is stronger than P2P ride sharing. This is in part attributed to the different business models and the different objects of trust which have been impacted by COVID-19.

These different trajectories of P2P mobility innovation adoption will be drawn upon to inform a series of diffusion scenarios exploring these future uncertainties in the next chapter.

Chapter 6: Quantifying the emissions impacts of the adoption and diffusion of P2P mobility innovations

6.1. Introduction and rationale

This chapter addresses the question of "***what impacts could the adoption of P2P mobility have on emissions?***". It is estimated that personal cars are parked 95% of the time (Barter, 2013). Both P2P ride sharing and P2P car sharing harness the idle capacity associated with private vehicle ownership. Both innovations offer the potential for emissions reductions through three main effects: substitution, shedding, and suppression.

The substitution effect quantifies the change in per-person emissions due to using P2P mobility instead of other modes of transport. The emissions estimates from the substitution effect are expressed relative to something else; in this case alternative modes of transport (i.e., the counterfactual). The substitution effect is regarded as a behaviour effect, as the change in emissions arises from a change in behaviour (the choice of transport mode). The suppression effect quantifies the emissions impacts from foregone vehicle purchases as a result of alternatives to private car ownership (Martin and Shaheen, 2016). In this case, the suppression effect estimates the total impact on emissions if the need for adopters to buy an additional vehicle is suppressed due to their adoption of P2P mobility. The estimates for the suppression effect use adopters' stated behaviours as opposed to revealed behaviours. This estimate is based on the numbers of adopters of P2P mobility who state that they are less likely to buy an additional car, due to their adoption of P2P mobility. The shedding effect quantifies the emissions impacts from enabling individuals to get rid of their personal cars (Martin and Shaheen, 2016). In this case, the shedding effect describes the emissions impacts of adopters who are able to "shed" their vehicle due to adopting P2P mobility. While the suppression effect is based on adopters' stated behaviours, the shedding effect uses adopters' revealed behaviours (i.e., the actual numbers of adopters who have shed a personal vehicle due to P2P mobility).

The potential for P2P car sharing and P2P ride sharing to reduce emissions is contingent on the interplay between numerous socio-demographic, contextual, use-behaviour, and institutional factors. **The aim of this chapter is to estimate the potential impacts that the adoption of P2P mobility could have on CO_2 emissions.** A 3-step approach was taken to explore the range of impacts that the adoption of P2P mobility could have on emissions. Each step draws upon different data sets and explores the impacts of the adoption of P2P mobility at different analytical scales. At each step, the changes in CO_2 emissions were estimated using a combination of the substitution, suppression, and shedding effects.

These three analytical scales are introduced in the next section, and an overview of the structure is provided.

Throughout this chapter the four adopter groups identified and analysed in the previous two chapters (P2P ride sharing commuters, P2P ride sharing one-off users, P2P car sharing peer-providers and P2P car sharing peer-users) are treated as separate groups. These four distinct groups have different use characteristics, and different perceptions (and requirements) of trust and institutional support. Using these four adopter groups to frame and explore this research question will demonstrate the diversity of emissions impacts of using P2P mobility and answer the research question through a more in-depth approach. As in the previous chapters, the use of the two P2P mobility case studies is not to draw a direct comparison between the emissions impacts of these two example innovations. Instead, the inherent differences between these two case studies allow for them to be used to analytically explore the diversity of potential impacts of P2P mobility, and to explore the dependencies underscoring the future diffusion of P2P mobility and what this could mean for emissions. Each adopter group tells one part of the story of the adoption of P2P mobility innovations. The similarities and differences between these four adopter groups allow for an analytical exploration of the key factors determining emissions impacts (i.e., the relative importance of use characteristics, potential population sizes, and influence of trust and institutional support).

Undertaking an emissions accounting in this manner involves inherent uncertainties. Therefore, as well as aiming to provide estimates of the potential emissions impacts, this chapter also aims to critically reflect on the process of characterising uncertainties.

6.1.1. Survey sample: current adopters

The per-person emissions impacts of using P2P mobility are estimated using data quantifying the use-behaviours of current adopters. Use-behaviour data were collected as part of the survey detailed in chapter 4. Uncertainties about use-behaviours (frequency of use, distance of journeys, and occupancy rates) and the reference points used for comparative purposes, i.e., what would an adopter have done otherwise, are explored at this stage. Per-person emissions were not estimated for P2P car sharing providers for two reasons: first, there is no substitution effect, and second, the vehicle emissions are already accounted for at the peer-user level. This avoids potential double-counting.

6.1.2. Population level estimates

The population level emissions impacts are estimated if adoption of P2P mobility were scaled up from the different adopter samples to the UK population. There were 2 approaches taken to this. First, the full potential impact was estimated, assuming everyone in the UK who would be capable of doing so adopts the innovation. Next, the behaviourally realistic estimate was calculated, taking into consideration the contextual, institutional, and socio-demographic factors which limit and shape adoption in the real world. Exploring both approaches to estimating the emissions impacts at the population level explores a new layer of uncertainty; how influential certain factors are in the scaling of emissions impacts.

6.1.3. Future scenario exploration

Using a 2x2 matrix that varies two key uncertainties, four scenarios were developed to explore the uncertainties impacting the future diffusion and adoption of P2P mobility at the national scale. This is a method of exploring future change conditional on certain trends (Rhydderch, 2017). Key uncertainties which impact the future are presented on the X and Y axes, thus creating four distinct future scenarios. The decision of which uncertainties to explore in this way will be discussed in section 6.6.1. At this stage COVID-19 is introduced as a contextual factor, and the scenarios developed consider different COVID and post-COVID recovery trajectories.

6.2. Hypotheses

6.2.1. Individual and population analytical scales

While the emission reduction potential of B2C car sharing has been quantified (see Martin *et al*., 2010; Firnkorn and Muller, 2011; Martin and Shaheen, 2011), there are no current publications exploring this exclusively in a P2P context and in the UK. In their 2020 paper quantifying emissions impacts of B2C car sharing through LCA, Amatuni *et al*., state that they "focus only on the B2C platforms as the impacts of peer-to-peer car-sharing platforms on travel behaviour have yet to be statistically quantified".

Arbeláez Vélez and Plepys (2021) compared the emissions impacts of B2C and P2P car sharing fleets and found that B2C vehicles had a higher emissions reduction potential than P2P. This was because "B2C fleets are more fuel efficient and have a higher percentage of low- or zero-emissions vehicles" (p11). However, the authors only looked at the use-phase emissions and not the embedded emissions in vehicle production, maintenance, and end-of-life. They quantify emissions reductions through the substitution and shedding effects. Furthermore,

they did not estimate any emissions differences caused by different typical use behaviours between use of B2C and P2P car sharing vehicles, assuming that both types of vehicles are used with the same frequency, distance, and occupancy rates. The emissions differences observed between P2P and B2C car sharing arose from differing fleet compositions resulting in different vehicle emissions factors.

In their 2017 briefing, Bondorova and Archer review the evidence for the relationship between car sharing and car use. Ultimately, they find that the 'overwhelming majority' of the evidence shows that car sharing and ride sharing schemes across different business models do offer the potential of a net reduction in car use. However, the authors do not quantify the potential for emissions reductions resulting from this reduction in car use, and furthermore do not assess the suppression and shedding effects. Nijland and van Meerkerk (2017) explore the emissions impacts of car sharing in the Netherlands and find that there are emissions reductions, and these caused by driving fewer kilometres, reduction in levels of car ownership (the shedding effect), and the reduced need to purchase a second or third car (the suppression effect). However, the data used to derive these estimates does not focus exclusively on P2P car sharers (20% of the sample use P2P car sharing and 80% of the sample use B2C car sharing). The authors recognise "… we did not analyse the impacts of each type of car sharer in full detail. However, this is a very interesting field of study, and research in that area would certainly yield new insights" (p90). During the focus groups with P2P car sharing peer-providers (chapter 5), it was found that some peer-providers purchase multiple vehicles for the sole purpose of renting them on P2P platforms, and thus it could be argued are instead creating capacity instead of harnessing idle capacity. For this reason, ***it is expected that P2P car sharing providers experience an increase rather than a reduction in emissions, through the shedding and suppression effects.***

The potential to reduce emissions through the substitution effect is dependent on what P2P mobility is substituting for (Nijland and van Meerkerk, 2017). Most P2P car sharing adopters stated that they would have used an alternative private vehicle to make their latest journey, had a match not been available through a P2P car sharing scheme (in chapter 4). Therefore, ***it is expected that P2P car sharing does not lead to a change in emissions, through the substitution effect.***

In the case of P2P ride sharing, the emissions impacts through the substitution effect have been quantified in various studies. Minett and Pearce (2011) find that P2P ride sharing ("carpooling") leads to a reduction in emissions when compared to single occupancy

vehicles. Interestingly, the authors also find that P2P ride sharing leads to a reduction in emissions when compared to a mix of single-occupancy and public transport (bus). The emissions reductions compared to single-occupancy and public transport arise from the "deadhead" emissions of public transport (in this case, the emissions returning an empty bus to the depot), estimated occupancy rates of public transport, and the average speeds of busses vs. ride sharing vehicles. On the other hand, Yin *et al*. (2018) find evidence of substantial "rebound effects" when P2P ride sharing is used instead of public transport or active modes of travelling and propose that "local authorities should focus ride-sharing policies in long distance trips, as the ones with the greatest mitigation potential" (p896). This highlights the importance of use characteristics in determining the potential impact on emissions. In this study, it is expected that where the adoption of P2P ride sharing occurs instead of travelling by private vehicle, ***P2P ride sharing leads to a reduction in emissions, through the substitution effect.***

6.2.2. Future scenarios

This chapter also explores the importance of trust and institutional support for shared mobility through the development of four distinct future scenarios. During the focus groups (chapter 5), trust and institutional support for shared mobility were found to be important for all adopter groups, to varying degrees. Trust and institutional support impact emissions estimates in the different future scenarios by impacting the population sizes (i.e., the numbers of people who are willing to use P2P mobility in each scenario), and the use characteristics (i.e., the frequency, distance, and occupancy rates of journeys people are comfortable making in each scenario). Therefore, ***it is expected that the greatest emissions reductions for all adopter groups occur in the high-trust, high institutional support scenario.***

However, it is expected that trust and institutional support have differing levels of importance for different adopter groups. Mattia *et al*., (2021) compared the relative impacts of trust in platform, and perceived environmental, social, and economic benefits of people's intentions to use P2P ride sharing and found that trust is the most influential variable predicting non-adopters' intentions to adopt. This finding supports those from chapter 5, which suggest that trust is most important to P2P ride-sharers, and particularly to one-off users. Furthermore, P2P ride sharing can operate informally outside the bounds of institutions (and indeed mediating platforms). Therefore, ***it is expected that high trust is***

more important than high institutional support for adopters of P2P ride sharing, and the high-trust scenarios results in the largest emissions reductions for these adopter groups.

Institutional support can present an insurmountable barrier to the adoption and diffusion of P2P car sharing. Münzel *et al*. (2018) explore the supply of B2C and P2P shared cars across five Western European countries and conclude that the low number of shared P2P cars in the UK (the lowest across the five countries studied), can be attributed to "the strict insurance regulations in the UK for renting out ones own car" (p8). Furthermore, they find that "infrastructure and institutions" (p5), including regulation, tax regimes, and supportive policies greatly shape the car sharing system. For these reasons, ***it is expected that high institutional support is more important than high trust for adopters of P2P car sharing, and the high institutional support scenarios results in the largest emissions reductions for these adopter groups.***

6.3. Overview of approach

6.3.1. Analytical scales

As outlined in section 6.1, quantitative models were developed to explore the emissions impacts of the adoption of P2P mobility at different analytical scales. First, estimates of the annual change in emissions were calculated at the per-person level. Next, the potential emissions impacts were calculated which estimate the potential annual change in emissions if the adoption of P2P mobility were scaled up to the national (UK) population level. Finally, using the 2x2 matrix technique, four scenarios were developed which explored the potential impacts of key uncertainties on the future adoption and diffusion of P2P mobility. The potential emissions impacts under each of these four different futures were quantified.

Figure 10 visualises the different analytical scales and the progression between them. Each analytical scale has a specific methodology and results. This chapter is subsequently structured by analytical scale. The rest of section 6.3 will describe aspects of the common methodological approach across analytical scales, and the specific methodologies will be presented in these different sections.

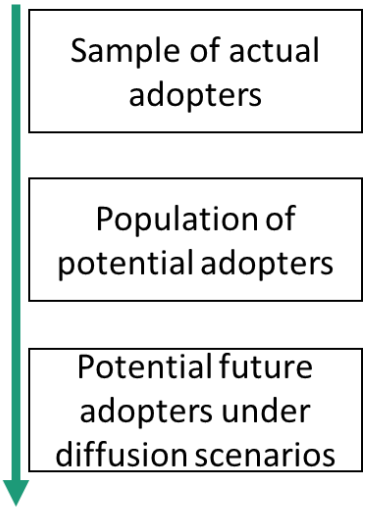

Figure 10: An overview of the different analytical scales explored in this chapter.

6.3.2. Emissions impacts effects

To estimate the impacts that using P2P mobility could have on emissions, the three effects (substitution, suppression, and shedding) were modelled. The analysis in this chapter will explore how these three effects present and interact across the different adopter groups.

6.4. Per-person level: methodology and results

6.4.1. Estimating emissions impacts

The per-person estimates for the annual CO_2 emissions arising from the use of P2P mobility were calculated using the following formula:

$$(p.km \times \frac{kgCO_2}{v.km}) \div \frac{p}{v}$$

Equation 1: calculating annual CO_2 emissions per person.

Where p.km = passenger kilometres; v.km = vehicle kilometres; p = number of passengers; v = number of vehicles (in this project this is always 1).

The data providing estimates for the distance, frequency of use and occupancy rate came from the survey (chapter 4). The emissions from using P2P mobility were compared to a reference point. The counterfactual emissions were used as the reference point. The counterfactual emissions refers to the emissions which would have happened had adopters used alternative modes of transport (instead of P2P mobility).

The decision on which alternative modes of transport to use as the reference points was informed by the surveys (see chapter 4). Adopters were asked what they would have done otherwise for their most recent journey if a P2P match had not been available (although recognising that their most recent journey may not be representative of all their P2P journeys as a limitation). The two most common responses for each adopter group were used as reference points. The weighted average emissions of these reference points was used for each adopter group to explore counterfactual uncertainty (see Table 16).

Table 16: The counterfactuals used as comparisons for each adopter group.

Adopter group	**Counterfactuals for comparison**
P2P ride share commuters	Travelling in a privately owned, single occupancy vehicle
	Travelling by public transport[9]
P2P ride share one-off users	Travelling in a privately owned, single occupancy vehicle
	Travelling by public transport
P2P car share users	B2C car rental
	Travelling by public transport
P2P car share providers	Not Applicable

It was assumed that annual p.km is constant, and therefore increasing use of P2P mobility decreases use of alternate modes (and vice versa). However, this is recognised as a limitation of this study, and is explored in the discussion section. Furthermore, it is recognised that not travelling at all is a possible counterfactual.

To capture the range of potential emissions impacts and reflect the variation in adopters' use behaviours, high, medium, and low estimates of the annual emissions were calculated. Where high, medium, and low estimates for variables were used, these were the 75th, 50th, and 25th percentiles respectively of the input datapoints.

6.4.1.1. *Emissions factors and lifetime vehicle emissions*

The emissions factors used for each reference point and their sources are presented in Table 17. The lifetime emissions estimates are presented in Table 18.

[9] Public transport = trains + light rail + busses + coaches

Table 17: The emissions factors used for each reference point.

Reference point	Emissions factor	Source / Rationale
Travelling in a privately owned, single occupancy vehicle	0.15105 $kgCO_2$/v.km (where v=1)	Medium estimate for vehicle emissions factors, based on a medium size UK car (BEIS, 2019)
Travelling by public transport	0.0351 $kgCO_2$/p.km	Medium estimate for public transport emissions factors. Averaged emissions per passenger km (BEIS, 2019)
B2C car rental	This was regarded as a "like-for-like" substitution, and therefore used the same emissions factors as the P2P mobility estimates[10]	

Table 18: The data points and sources used to estimate the lifetime emissions of a car.

Variable (unit)	Data source	Values used	High, medium, and low OR midpoint estimates?
Embodied emissions (tCO_2)	Transport and Environment (2021)	7.8 6.7 5.6	High Medium Low
Lifetime mileage of car (km)	Society of Motor Manufacturers and Traders (2015)	150000	Midpoint
Vehicle emissions factor ($kgCO_2$/km)	2019 Government greenhouse gas conversion factors methodology paper (2019)	0.25 0.15 0.11	High Medium Low
Lifespan of UK car (years)	Department for Business, Energy and Industrial Strategy (2019)	13.9	Midpoint

6.4.1.2. *Estimating the substitution effect*

The variables estimating the per-person emissions impacts came from two sources, presented in Table 19.

[10] Arbelaez Velez and Plepys (2021) suggest that B2C car sharing vehicle fleets are typically younger and have lower emissions factors than privately owned cars. It is not assumed that this will be the case for P2P car sharing given that the fleet of P2P cars is comprised of privately owned cars. While the vehicle age restrictions from some P2P car sharing platforms means that the fleet of P2P vehicles may be younger than average, it was decided to assume that the emissions factors would be the same due to a lack of available data.

Table 19: Data and their sources used to generate the per-person emissions impacts.

Variable	Data source
Frequency of use	Adopter survey
Distance	Adopter survey
Occupancy rate	Adopter survey
Vehicle emissions factors	2019 Government greenhouse gas conversion factors methodology paper (Hill *et al*., 2019)

The annual emissions were calculated using the formula presented in section 6.4.1. Both the annual reference point emissions, and the annual P2P mobility emissions were estimated in this way. Next, the annual substitution effect at the per-person level was estimated by:

$$annual\ reference\ point\ emissions - annual\ P2P\ mobility\ emissions$$

Equation 2: Annual substitution effect calculation.

6.4.1.3. *Estimating the suppression effect*

The suppression effect at the per-person level was estimated as the propensity of an individual to not purchase a vehicle. Section 6.5 details the population level estimates and data sources for the suppression effect. These are expressed as percentages across a population. The same percentage value was used as an estimate of the propensity of an individual to adopt P2P mobility. The suppression effect at the per-person level was estimated in the following way:

$$Annual\ GHG\ impact\ of\ suppression\ effect =$$

$$likelihood\ of\ adopter\ to\ suppress\ a\ vehicle\ (\%) \times \frac{vehicle\ lifetime\ emissions\ (kgCO_2)}{vehicle\ lifetime\ (years)}$$

Equation 3: Annual suppression effect calculation per person.

6.4.1.4. *Estimating the shedding effect*

The shedding effect at the per-person level was estimated as the propensity of an individual to shed their vehicle, in the same way as described above. The shedding effect at the per-person level was estimated in the following way:

$$Annual\ GHG\ impact\ of\ shedding\ effect =$$

$$likelihood\ of\ adopter\ to\ shed\ a\ vehicle\ (\%) \times \frac{vehicle\ lifetime\ emissions\ (kgCO_2)}{vehicle\ lifetime\ (years)}$$

Equation 4: Annual shedding effect per person.

6.4.2. Results: Per-person level impacts of adopting P2P mobility on emissions

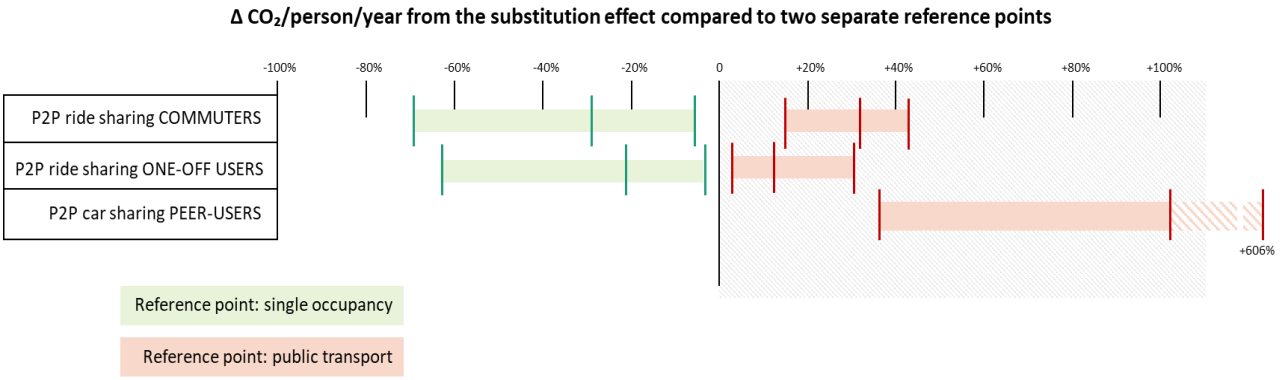

Figure 11: The percentage change in emissions arising from the substitution effect for each adopter group, when comparing P2P mobility to the two reference points of single occupancy and public transport. The bars show the data range, and the darker lines within the bars show the specific values for the low, medium, and high estimates.

Figure 11 shows the emissions impacts of using P2P ride sharing change directionality depending on the reference point. For the rest of this chapter, the weighted average reference point will be used in analyses.

The change in emissions compared to the weighted reference point for the different adopter groups arising from the three effects are presented in Figure 12. Note the different scale compared to Figure 11.

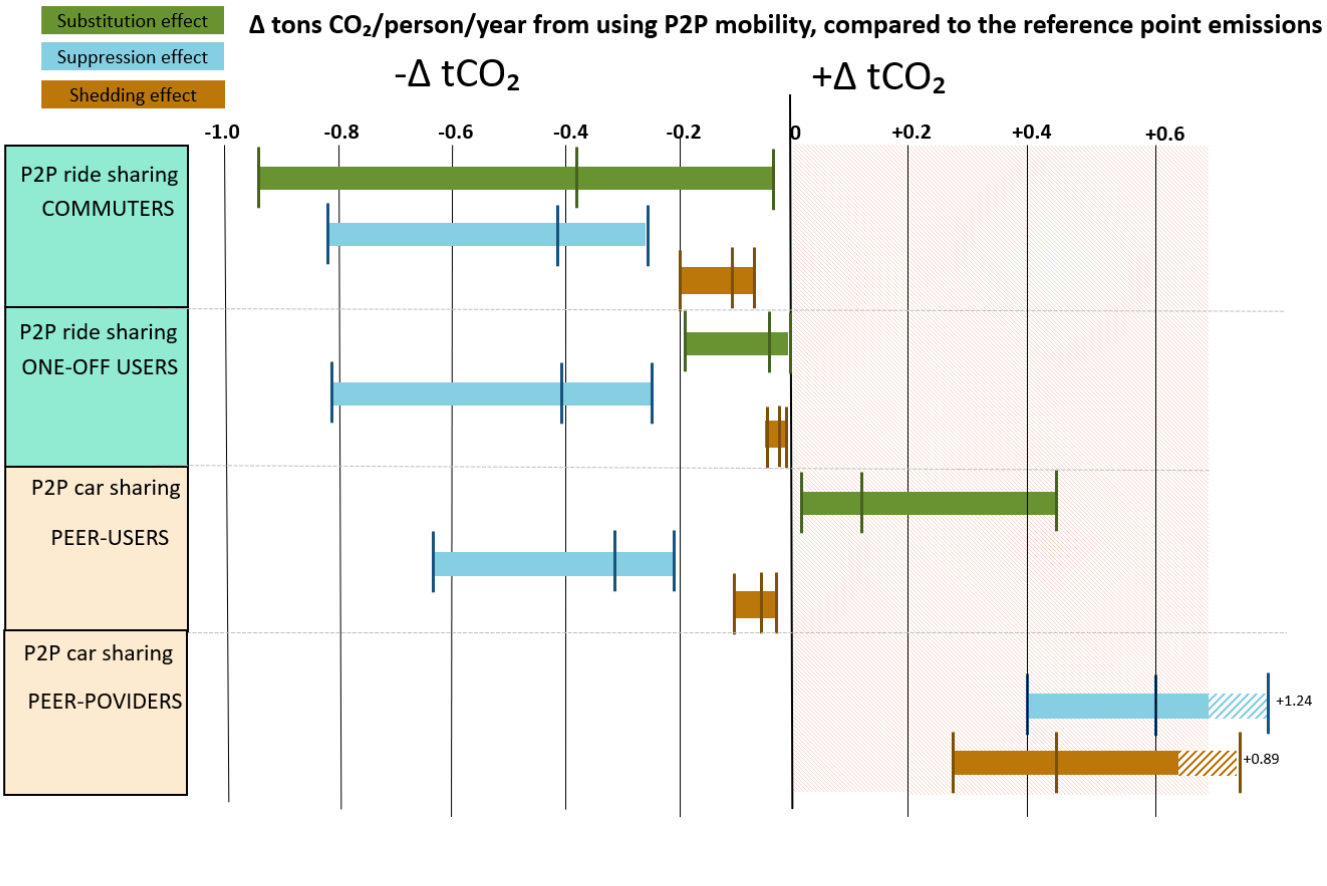

Figure 12: The change in emissions in tCO_2 from the substitution, suppression, and shedding effects when comparing the use of P2P mobility to the weighted average reference point for each adopter group. The bars show the data range, the darker lines within the bars show the high, medium, and low estimates.

The P2P ride sharing commuters have the largest substitution and shedding effect of all adopter groups. The larger magnitude of both effects is explained by the comparatively high frequency of use. Using ride sharing on a regular basis instead of alternative modes of transport results in the largest emissions impacts annually. Commuters who ride share with others every day are in a better position to be able to get rid of their car than other adopter groups who use P2P mobility less frequently. This also highlights the importance of having suitable, long-term alternatives for the shedding effect to be able to have an impact on emissions.

While the commuters and the one-off users have very similar suppression effects, both in terms of their overall magnitudes and their ranges, the one-off users have the smallest shedding effect of all adopter groups. The comparatively smaller shedding effect could be explained by their less frequent use of P2P ride sharing than commuters. Therefore, it is less likely that P2P ride sharing is seen as a viable alternative to car ownership for one-off P2P

ride sharers. The larger magnitude and range of the suppression effect compared to the shedding effect is explained by the larger percentage of the adopter populations who state that they would be less likely to buy an additional car, compared to adopters who have actually "shed" their car.

Peer-users of P2P car sharing have the only positive substitution effect (i.e., resulting in increased emissions). The reference point which this estimate was compared against was taken from estimates for B2C car rental and estimates from public transport. The use of P2P car sharing has a much greater emissions impact than the use of public transport, and B2C car rental was considered a "like-for-like" substitution (available evidence showed no systematic differences between the types of vehicles used for P2P car sharing and B2C car rental, and therefore the vehicle emissions factors were kept constant).

While the substitution effect resulted in an increase in the per-person emissions for peer-users of P2P car sharing, the suppression and substitution effects lead to reductions in emissions. The different directionality of the impacts demonstrates both the relative importance of the reference point in calculating the substitution effect, and the ways in which the three modelled effects can act in different ways.

There is an increase in emissions for peer-providers of P2P car sharing from the suppression and shedding effects. This demonstrates the anti-suppression and anti-shedding effects. The anti-suppression and anti-shedding effects are larger than the peer-user suppression and shedding effects. The lifetime emissions from the additional purchases of vehicles by peer-providers for use on P2P car sharing platforms are not negated by the suppression and shedding effects of peer-users.

However, although the suppression and shedding effects at the per-person level suggest that overall, there is a net increase in emissions from using P2P car sharing, estimates from P2P car sharing platforms in the UK suggest that the ratio of registered peer-providers to peer-users is 1:30 – 1:50 (private communication with P2P car sharing platform employee, 2020). Therefore, while there is a positive impact in emissions at the per-person level, at the population level the aggregate effects may still result in a negative effect.

6.4.3. Summary

At the per-person level, adoption of P2P mobility causes a range of emissions impacts, both in terms of direction (reduction or increase), and relative magnitude. The substitution effect, in other words what P2P mobility is substituting for, is most important in determining the

directionality of the emissions impacts. The usage characteristics were most important in determining the magnitude of the potential impacts. Where high frequency of use is combined with large distances this results in the largest potential impacts.

To summarise, the adoption of P2P mobility, particularly P2P ride sharing (given the directionality of the substitution effect) can significantly reduce emissions for individual users. The largest emissions reductions come from commuters who ride share frequently. A commuter could potentially save 0.38 – 1.96 tCO_2 annually by switching to P2P ride sharing, from the combination of the substitution, suppression, and shedding effects. For context, the average annual CO_2 emissions per person from travel are 1.3 tCO_2 (DEFRA, 2018) (this estimate only includes direct emissions from transport). Furthermore, commuting accounts for 25% of transport emissions and 5% of the UK's total emissions (MobilityWays, 2020). This demonstrates the scale of the potential emissions reductions impacts if commuting by P2P ride sharing were adopted at scale. This will be explored and quantified in the following section.

6.5. National population level: methodology and results

6.5.1. Technical potential population

The technical potential emissions reduction (from a discrete action, such as P2P mobility use) is defined as "the reduction that would be achieved nationally from 100% adoption of the action" (Dietz *et al*., 2009, p1). The technical potential population refers to the number of adopters if everyone who was capable of doing so adopted the innovation. While the literature typically refers to this type of estimate as the "potential emissions reduction", this thesis will use the term "potential emissions impact" is used. This recognises that the universal adoption of P2P mobility may result in a potential increase of emissions in some instances.

6.5.2. Behaviourally realistic population

While the potential population assumes 100% adoption, there are contextual (e.g., geographical, socio-demographic), institutional, and personality factors which limit the actual uptake of P2P mobility innovations within a population (see Münzel *et al*., 2019; Axsen and Sovacool, 2019; Uteng 2019). These are taken into consideration when estimating the behaviourally realistic emissions impacts. As such, the behaviourally realistic population is significantly smaller than the technical potential population, however it is also a more valid

and reliable representation of the real world. The purpose of including the behaviourally realistic population estimate is to constrain the technical potential to a realistic level.

Population-level data sets were used to scale-up the adopter population. The decision of which key characteristics to use to inform this scaling-up was informed by the data collected in the surveys and the focus groups. Selected variables were matched onto population-level data sets to estimate the total number of behaviourally realistic adopters in the UK. Table 20 shows how the technical potential population and the behaviourally realistic populations were estimated.

Estimating the populations in this way does assume that there is no correlation between input variables. It is recognised that in the real world it is highly likely that some of these variables are correlated. This approach will be discussed as a limitation in the discussion.

Table 20: The datapoints used to estimate the total potential population and the behaviourally realistic populations.

Adopter group	**Data points used to estimate the technical potential population**	**Total technical potential population (millions)**	**Data points used to estimate the behaviourally realistic population**	**Total behaviourally realistic population (millions)**	**Sources**
P2P ride sharing Commuters	Number of commuters in the UK travelling to work in single-occupancy cars (see appendix 1.3 for further details)	19.6	Total potential population, aged 20-64, in businesses with more than 250 employees, living in urban or semi-urban areas, trusting	2.9	• Department for Transport (TSGB01) • DEFRA rural/urban average • HOC briefing paper Number 06152 • ONS wave B18 (trust)
	Number of commuters in the UK travelling to work by public transport[11]	5.8	Total potential population, aged 20-64, in businesses with more than 250 employees, living in urban or semi-urban areas, trusting (i.e., potential peer-users)	0.9	• Department for Transport (TSGB01) • DEFRA rural/urban average • HOC briefing paper Number 06152
P2P ride sharing One-off users	Number of UK adults (20 – 69) with a driving license and access to a household car (i.e., potential peer-providers)	30.1	Total potential population, trusting, in urban or semi-urban areas, (i.e., potential peer-providers)	2.7	• ONS (People, population, and community Table A47)
	Number of UK adults (20 – 69) without access to a car (i.e., potential peer-users)	8.7	Total potential population, trusting, in urban or semi-urban areas, (i.e., potential peer-users)	0.8	• ONS (People, population, and community Table A47)
P2P car sharing providers	Number of privately owned cars in the UK less than 10 years old and below 3001cc	1.8	Total potential population (vehicles), owners aged 20-59, have a degree, urban or semi-urban, own at least 1 car, trusting	0.1	• Department for Transport (TSGB09 and VEH02) • ONS graduates in UK labour market 2017
P2P car sharing users	Number of adults aged 21 – 70, who have a driving license but do not have a car	3.3	Total potential population, have a degree, urban or semi-urban	0.8	• ONS (April 2020 population estimate) • Department for Transport (NTS0201) • ONS graduates in UK labour market 2017

[11] Public transport = trains, light rail, busses, and coaches.

6.5.3. Estimating the substitution effect

The substitution effect at the population level was estimated by multiplying the per-person estimate of the substitution effect by the population size (shown in Table 20).

6.5.4. Estimating the suppression effect

The suppression effect calculates an emissions impact based on an adopter suppressing the purchase of a car. This was estimated in the following way (see section 6.4.1 for a definition of terms):

$$Total\ annual\ GHG\ impact\ of\ suppression\ effect = \%P2P\ adopters\ who\ don't\ buy\ an\ additional\ car \times population\ of\ P2P\ adopters \times \frac{vehicle\ lifetime\ emissions}{vehicle\ lifetime}$$

Equation 5: the annual suppression effect calculation.

The sources of the values used as estimates of the shedding effect are shown in Table 21.

Table 21: The sources of the values used as estimates for the suppression effect for each adopter group, and justifications of why each source was used.

Adopter group	**Values used as suppression effect estimates (%)**	**Source of estimates for suppression effect**	**Justification**
P2P ride sharing Commuters	-20	Value informed by focus group	No comparable values were found in a literature search
P2P ride sharing One-off users	-10	Value informed by focus group	No comparable values were found in a literature search
P2P car sharing providers	+30	Survey data	Primary data collected in the survey
P2P car sharing users	-51	England and Wales Annual Car-Club Survey, 2019	Sufficient data not collected through primary methods

The direction of the suppression effect is not fixed. In the case of P2P car sharing providers, 40% of survey respondents stated that since starting using P2P car sharing, they were now ***more*** likely to buy an additional car, compared to 10% who stated that they were now less likely to do so. This is termed the "anti-suppression" effect. This demonstrates that while

the innovations of P2P ride sharing and P2P car sharing can offer potential emissions reductions, this is wholly contingent on the ways in which they are used, and the characteristics of the adoption patterns.

The estimate for the lifetime emissions of a car was calculated as below. It is recognised that this approach does not account for increasing efficiency of newer cars.

$$total\ C0_2 = C0_2 embodied + (v.km\ \times \frac{C0_2}{v.km})$$

Equation 6: The lifetime emissions of a vehicle calculation.

6.5.5. Estimating the shedding effect

The shedding effect quantifies the emissions impacts from adopters who get rid of, or shed, their car. This was estimated in following way:

$$Total\ annual\ GHG\ impact\ of\ shedding\ effect$$
$$= \%P2P\ adopters\ who\ shed\ a\ car$$
$$\times population\ of\ P2P\ adopters\ \times \frac{vehicle\ lifetime\ emissions}{vehicle\ lifetime}$$

Equation 7: The annual shedding effect calculation.

The shedding effect was included as a variable in the emissions calculations as a percentage estimate of the number of adopters who "shed" their car as a result of joining a P2P mobility scheme. The sources of the values used as estimates of the shedding effect are shown in Table 22.

Table 22: The sources of the values used as estimates for the shedding effect for each adopter group, and justifications of why each source was used.

Adopter group	**Values used as shedding effect estimates (%)**	**Source of estimate for suppression effect**	**Justification**
P2P ride sharing Commuters	-5	Value informed by focus group	No comparable values were found in a literature search
P2P ride sharing One-off users	-5	Value informed by focus group	No comparable values were found in a literature search
P2P car sharing providers	+20	Value informed by focus group	No comparable values were found in a literature search

P2P car sharing users	-18	England and Wales Annual Car-Club Survey, 2019	Data not collected through primary methods

An "anti-shedding" effect is apparent for P2P car sharing providers. This differs from the anti-suppression effect, as it is the percentage of adopters who have bought an additional car since joining a P2P car sharing scheme, rather than those who state that they would be more likely to do so.

6.5.6. Results: Population level impacts on emissions if adoption is scaled up

Two methods of estimating the emissions impacts were used. The technical potential estimates "the reduction that would be achieved nationally from 100% adoption of the action" (Dietz *et al*., 2009, p1). The behaviourally realistic emissions impacts considers the contextual, institutional and personality factors which limit the actual adoption of P2P mobility innovations.

Figure 13 shows the technical potential emissions impacts and Figure 14 shows the behaviourally realistic emissions impacts. It is important to highlight the different scales in the two figures. Both figures show the impacts from all three modelled effects: the substitution effect, the suppression effect, and the shedding effect. The technical potential emissions impact across all adopter groups and all effects were between seven and ten times larger (in both directions) than the behaviourally realistic emissions impacts. This demonstrates the importance of building population level estimates using data which take into consideration the contextual, institutional, and personality factors which shape the adoption and diffusion of P2P mobility.

The potential emissions impacts are included here to provide context and comparison for the behaviourally realistic estimates, although the analysis will focus on the behaviourally realistic estimates as these results address the research question for this chapter. For context, the total CO_2e emissions from domestic transport in the UK are approximately 122 million tons annually (Department for Transport, 2021a), and the annual emissions from private cars and taxis are estimated to be 68 Mt CO_2e (Department for Transport, 2021b).

6.5.6.1. *Maximum technical potential emissions impacts*

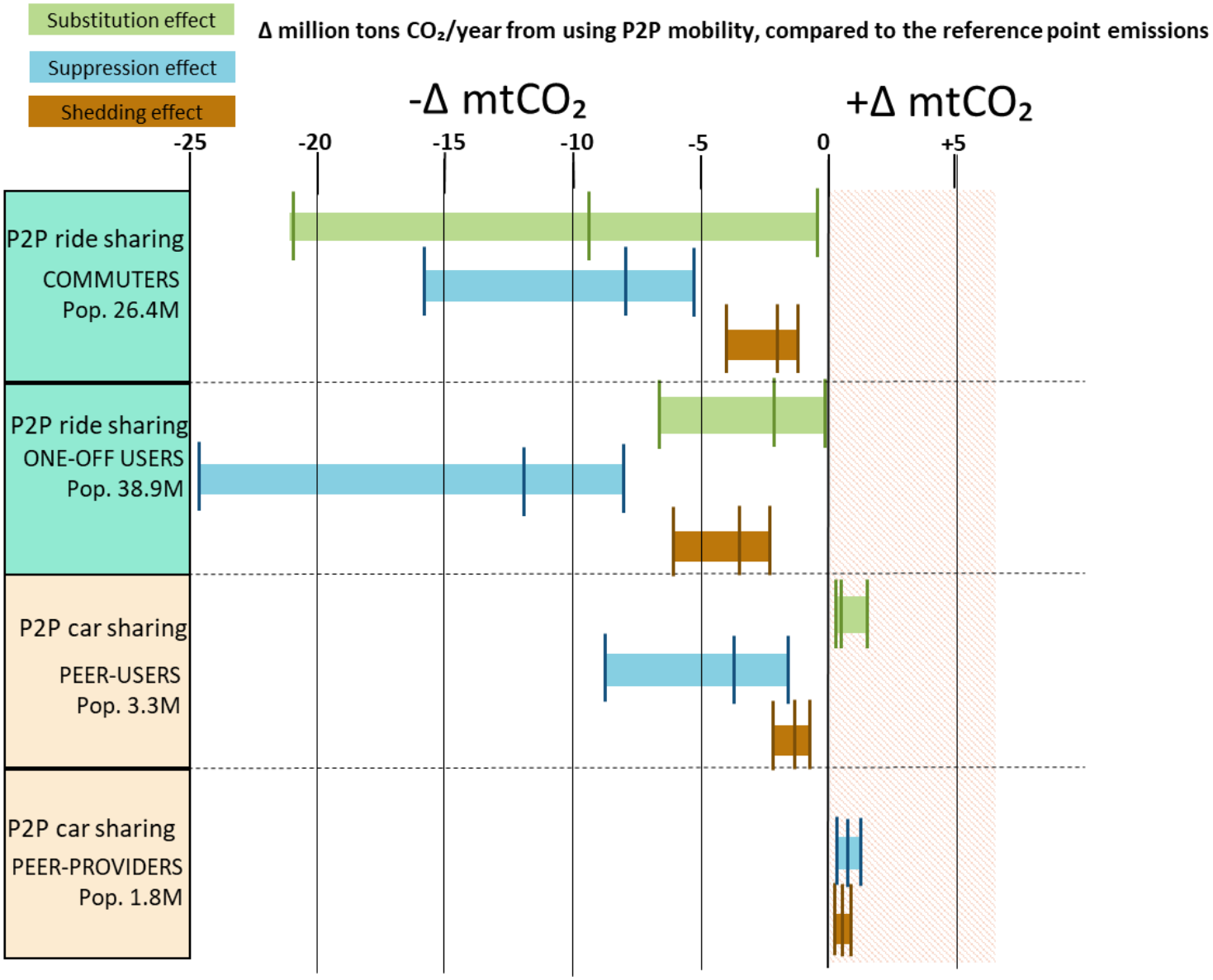

Figure 13: The change in emissions for the substitution, suppression, and shedding effects for each adopter group under the technical potential population.

6.5.6.2. *Behaviourally Realistic Emissions Impacts*

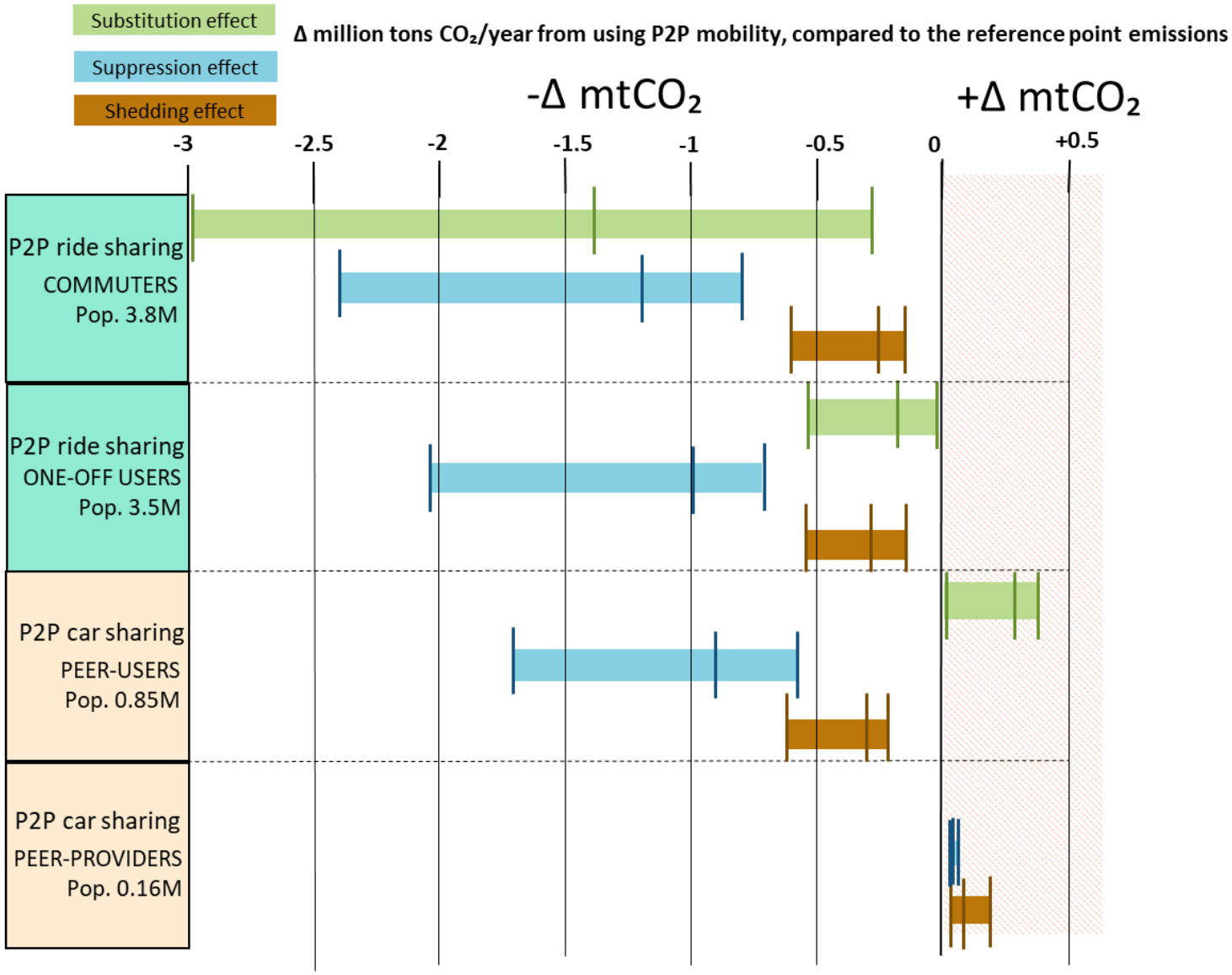

Figure 14: The change in emissions for the substitution, suppression, and shedding effects for each adopter group under the behaviourally realistic population.

While the behaviourally realistic population sizes of commuters and one-off users were similar (3.8 and 3.5 million respectively), there were large differences in the emission reduction estimates arising from the substitution effect. The commuters' estimate of the substitution effect has both the largest magnitude, and the largest range between the high, medium, and low estimates of all the three effects modelled. This is attributed to the fact that there is a greater range of frequency of use for the commuters than the other adopter groups; the high estimate assumes that commuters use P2P ride sharing every workday, equalling 262 days/year. One-off users use P2P ride sharing much less frequently. This demonstrates how frequency of use can be an important factor in determining the magnitude of the substitution effect when calculated as an annual estimate. Furthermore, the similar population estimates for commuters and one-off users show that the use characteristics can be more important than population size alone in determining potential emissions impacts.

The suppression effect causes the largest potential emissions reductions out of the three effects for one-off users. This difference stems from the differences in the frequency of use (as mentioned the population sizes are relatively similar between the commuters and the one-off users). For one-off users, the greatest emissions savings potential come from the avoided emissions from not having to purchase an additional car, rather than substituting alternative modes of transport for P2P ride sharing.

For P2P car sharing peer-users the substitution effect results in an increase in emissions. However, both the suppression and shedding effects lead to a net reduction in emissions. On the other hand, P2P car sharing providers differ from the other three adopter groups in that the suppression and the shedding effects for both these groups result in an increase in emissions, through the anti-suppression and anti-shedding effects. The occurrence and the magnitude of the anti-shedding and anti-suppression effects support the hypothesis that there would be an increase in emissions for P2P car sharing providers. However, the aggregate emissions change across both peer-providers and peer-users of P2P car sharing show that overall, the diffusion of P2P car sharing causes a net reduction in emissions (in contrast to the per-person level, see section 6.4). This is due to the smaller population size of P2P car sharing providers, and the smaller percentages of peer-providers who reported they would buy an additional car, compared to the percentage of peer-users who would suppress or shed a personal car.

6.5.7. Summary

The substitution effect is primarily influenced by the reference point. However, the suppression and shedding effects are primarily influenced by the adopter population size, and the percentage of adopters for whom P2P mobility is a viable alternative to car ownership.

The differences between the suppression and shedding effects across the adopter groups demonstrate that adopters' perceptions of P2P mobility and the contextual settings in which they use them are pivotal in determining the ultimate impacts in terms of emissions. This is even more prominent at the population level, where the potential population size has a large impact on the magnitude of the suppression and shedding effects.

The largest reductions in emissions occur where P2P mobility can be regarded as a viable alternative to private car ownership which still provides adopters with the attributes of private cars they value. The suppression and shedding effects are the largest for P2P ride sharers. Regarding P2P car sharers, the presence of an anti-shedding and anti-suppression effect highlight the different motivations and contexts of this adopter group. As discussed in the previous chapter, there are peer-providers of P2P car sharing who buy multiple vehicles for the sole purpose of renting them out on platforms, adopting a "micro-entrepreneurial" business model (fleet-providers).

The differences found in this section will be used to develop scenarios in the following section, exploring different futures for the adoption and diffusion of P2P mobility and the associated impacts under these scenarios.

6.6. Future scenarios: methodology and results

6.6.1. Development of future scenarios

A 2x2 matrix analysis was conducted to explore the potential emissions impacts of P2P mobility under a range of future diffusion scenarios. This method explores different scenarios as narratives in the mid to long-term future (Rhydderch, 2017). To develop a 2x2 matrix, two key uncertainties which are expected to heavily shape the future are selected and visualised on the X and Y axes, intersecting to form four quadrants. These four quadrants represent four distinct future scenarios.

The two key uncertainties selected for this 2x2 matrix were trust and institutional support for shared mobility. As explored in the previous chapter, trust is both a key driver of, and barrier to, the adoption of P2P mobility. Selecting trust as an uncertainty to explore allows

for an in-depth exploration of how trust can influence the future adoption of P2P mobility, what impacts varying degrees of trust could have on emissions impacts, and how trust could interact with other key factors determining emissions impacts.

Support for shared mobility was the second uncertainty. Support for shared mobility was conceptualised at the institutional and contextual level, rather than at the individual level. Examples of how this support could be manifested include: workplace incentives (e.g., parking costs, parking spaces); workplace policy (e.g., must share to get parking permit); promotion of shared mobility as part of workplace sustainability goals; information campaigns promoting one-off ride sharing; information campaigns promoting P2P car sharing; transparent and easy insurance for P2P car sharing; and parking / other benefits for P2P car sharing vehicles.

By selecting these two different types of uncertainties – trust as an uncertainty at the individual level, and support for shared mobility at the institutional and contextual level, an exploration of the uncertainty space could be explored. Furthermore, as these two uncertainties were found to be key barriers to the adoption of P2P mobility (see chapter 5), developing diffusion scenarios around these uncertainties explores how they could interact and differ for the different adopter groups. However, it is recognised that trust and institutional support represent just two of numerous uncertainties impacting the adoption of P2P mobility innovations. This limitation is further explored in the discussion.

Figure 15 shows this 2x2 matrix and the uncertainty space explored in each of the four quadrants. While the scenario exploration was developed using data and assumptions from before the COVID-19 pandemic, both trust and institutional support for shared mobility have been heavily impacted by the impacts of COVID-19.

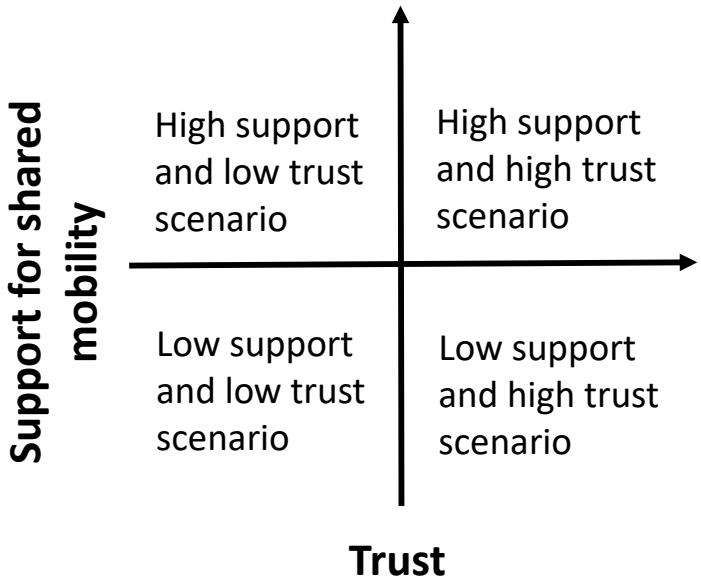

Figure 15: The 2x2 matrix showing the 4 scenarios created with strong support of mobility and trust as the 2 axes.

To explore the full uncertainty space, the scenarios were explored at two analytical scales: at the per-person level, and at the behaviourally realistic population level (where behaviourally realistic considers the specificities of each scenario). At the per-person level people's changing use behaviours in response to the different scenario conditions and the impacts of this are explored. The effect size changes for all three effects quantified. At the population level, the size of the scenario population changes. This is based on assumptions of how changing levels of trust and institutional support would impact the numbers of potential adopters.

6.6.1.1. *Per-person emissions impacts*

The per-person emissions impacts were explored through varying the values of the key input variables, as explored in section 6.4 (distance, frequency of use, occupancy rate). The ways in which each of these variables are expected to change under each scenario are described below. For each of these variables the high, medium, and low estimates used in the previous analyses were used to develop the scenarios. For example, if a scenario assumes that commuter's frequency of use would decrease, the low estimate for commuters' distance is used to build that scenario. Using this method to develop the scenarios ensures internal consistency and that the estimates for distance, frequency of use, and occupancy rates are bound by realistic assumptions grounded in data. The values used as estimates for these variables are presented in Table 22. This process will be described in this section.

Distance

Varying levels of trust and institutional support for P2P mobility are assumed to have no impact on the distance of journeys for commuters. Across all scenarios the distance of journeys is kept constant for commuters. On the other hand, for one-off users of P2P car sharing it is assumed that there is a positive correlation between trust and distance. One-off users who are more trusting are more likely to be comfortable making longer journeys with strangers.

For P2P car sharing adopters it is assumed that there is a positive correlation between trust and distance of journey. In the scenarios with high trust, it could be expected that overnight and multiple-day shares become more common. Although duration of sharing is not captured in the emissions calculations, there is assumed to be a correlation between duration and distance.

Frequency of use

The frequency of use is assumed to vary depending on the scenario for all adopter groups. For commuters in the scenarios with high support for shared mobility, the frequency of use is expected to increase. This is due to P2P ride sharing being regarded and encouraged as a more suitable commuting mode. It is assumed that the frequency of use for one-off users will decrease in the scenarios with low trust. As explored in chapter 5, there was consensus among the focus group participants who were one-off users that they regarded themselves as "trusting", and some as "risk-takers". This demonstrates the requirement of trust. Therefore, in scenarios with low trust it can be assumed that one-off users use P2P ride sharing less frequently.

P2P car sharing users are assumed to increase their frequency of using P2P mobility in scenarios with higher support for shared mobility, and to decrease their frequency of use in scenarios with lower support for shared mobility. Given the current contexts of P2P car sharing in the UK, it is assumed that institutional support for shared mobility will have a greater impact on the adoption and diffusion of P2P car sharing than levels of trust will. Many focus group participants who were peer-providers stated the importance of having mainstream insurance providers and parking benefits for P2P car sharing vehicles.

Occupancy rates

The occupancy rates for commuters are assumed to decrease in scenarios with low institutional support for shared mobility. High institutional support for shared mobility is

likely to increase occupancy rates for commuters as more people use P2P ride sharing because it is a suitable alternative to how they would otherwise commute. For one-off users, it is assumed that occupancy rates increase in scenarios where there is high trust.

Varying levels of trust and institutional support are assumed to have no impact on occupancy rates for P2P car sharing. This is due to peer-users having rival access to a vehicle. In instances where the occupancy rate may be greater than one, it is assumed that the peer-user is travelling with someone they know, who they would have travelled with anyway by other means of transport.

Vehicle emissions factors

The vehicle emissions factors were assumed to be constant across the scenarios. It is not expected that trust or institutional support for shared mobility impact this variable. The midpoint estimate for the vehicle emissions factor was used across all the scenarios.

Table 23: The range of values used to estimate each variable. Combinations of high, medium, and low estimates were used to develop the four scenarios. This process will be described later in this section.

Variable (unit)	Adopter group	High estimate	Medium estimate	Low estimate
Distance (km/journey)	Ride sharing Commuters	80.5	41.8	3.2
	Ride sharing One-off users	80.5	66.0	3.2
	Car sharing Peer-users	321.9	181.8	67.0
Frequency of use (journeys/year)	Ride sharing Commuters	262.0	131.0	36.0
	Ride sharing One-off users	36.0	12.0	2.0
	Car sharing Peer-users	12.0	6.0	2.0
Occupancy rate (p/v)	Ride sharing Commuters	3.0	2.6	2.0
	Ride sharing One-off users	2.0	2.7	2.0
	Car sharing Peer-users	1.0	1.0	1.0
Vehicle emissions factor ($kgCO_2$)	All adopter groups	0.2477	0.1511	0.1106

6.6.1.2. *Population level emissions impacts*

To estimate the population level impacts, the per-person emissions impacts for each scenario were scaled up to the population level. The estimates of the population for each scenario were multiplied by values which quantify the impacts of trust and institutional

support. Specifically, the data used were the propensity to trust strangers (as a measure of trust), and willingness to use P2P mobility (as a measure of institutional support).

The values used as these variables, their sources, and the justifications are detailed in Table 24. As an example, 55% of UK employees state that they would be willing to join a workplace P2P rideshare scheme. Therefore, the scenario population estimate would be multiplied by 55%, to get a more accurate estimate of the behaviourally realistic population of commuters under the scenarios which assume a medium estimate of trust.

Table 24: The values used to quantify trust and institutional support in the four future scenarios

Variable	Adopter group	High estimate	Medium estimate	Low estimate	Source / Justification
Trust	P2P ride sharing Commuters	80%	55%	10%	Medium estimate (55%) is the percentage of UK employees who are willing to join a workplace ride sharing scheme with colleagues. Low and high estimates are informed from this datapoint. Data taken from Understanding Society Wave 2.
	P2P ride sharing one-off users	24%	13%	5%	Percentage of the UK adult population who are trusting of strangers. All estimates are taken from Understanding Society Wave B18. High = score 6+, Medium = score 7+, Low = score 8+ on Likert scale 1-10, 1= "I will trust strangers", 10="I don't trust strangers".
	P2P car sharing peer-users and peer-providers	80%	65%	50%	Informed by focus group data as no appropriate secondary estimates were found. Trusting strangers was found to not be as important to P2P car sharers (chapter 5).
Institutional support	All adopter groups	200%	100%	50%	Informed by assumptions about the current state of institutional support in the UK and the influence that these mechanisms could have on adoption under the different

					scenarios. Both innovations use the same estimates to account for the multitude of manifestations of institutional support.

The scenario population was calculated for each of the four scenarios. The two dimensions of uncertainty explored in the scenario analysis impact the scenario population size. The estimated population size of each scenario is presented in Table 25. Although there is a larger population of P2P car-share users than P2P car-share providers for each scenario, P2P car sharing platforms in the UK currently operate with a 1:50 ratio of vehicles to peer-users. Therefore, the difference in population sizes in this scenario analysis were consistent with observed differences and within real world limitations.

Table 25: The estimated population for each adopter group under each scenario.

	Behaviourally realistic population (Millions)	**The *low support low trust* scenario (Millions)**	**The *high support low trust* scenario (Millions)**	**The *low support high trust* scenario (Millions)**	**The *high support high trust* scenario (Millions)**
Commuters	3.80	0.58	4.20	1.05	6.10
One-off users	3.50	0.86	1.71	3.91	7.82
P2P car sharing peer-users	0.85	0.21	0.83	0.33	1.32
P2P car sharing peer-providers	0.16	0.05	0.20	0.15	0.61

The emissions under each scenario were calculated as below:

$$p.km \times \frac{kgCO_2}{v.km} \div \frac{p}{v} \times (scenario\ population)$$

Equation 8: Annual scenario emissions calculation.

Substitution effect

The reference point emissions were calculated for each scenario. The substitution effect was estimated by comparing the emissions under each scenario with the relevant reference point emissions.

Suppression effect

The suppression effect was estimated using the method outlined in section 6.4.1.3. The values used as suppression effect estimates in this section are presented in Table 26. These estimates are informed by those presented in Table 21.

Table 26: The percentage of adopters who don't buy an additional car, these values were used as suppression effect estimates for each adopter group under each scenario.

Adopter group	**Behaviourally realistic estimate (%)**	**The *low support low trust* scenario (%)**	**The *high support low trust* scenario (%)**	**The *low support high trust* scenario (%)**	**The *high support high trust* scenario (%)**
Commuters	-20	-5	-20	-20	-50
One-off users	-10	-5	-20	-20	-50
P2P car sharing users	-51	-30	-51	-51	-70
P2P car sharing providers	+30	+20	+40	+40	+60

Shedding effect

The shedding effect was estimated using the method outlined in section 6.4.1.3. The values used as shedding effect estimates in this section are presented in Table 27. These estimates are informed by those presented in Table 22 (The behaviourally realistic estimates).

Table 27: The percentage of adopters who got rid of a private car, these values were used as shedding effect estimates for each adopter group under each scenario.

Adopter group	**Behaviourally realistic estimate (%)**	**The *low support low trust* scenario (%)**	**The *high support low trust* scenario (%)**	**The *low support high trust* scenario (%)**	**The *high support high trust* scenario (%)**
Commuters	-5	-2	-5	-5	-10
One-off users	-5	-2	-5	-5	-10
P2P car sharing users	-18	-5	-15	-15	-30
P2P car sharing providers	+20	+10	+20	+20	+30

6.6.2. Results: Potential impacts on emissions under future diffusion scenarios

Through scenario analysis, the effects of the two key uncertainties of trust and institutional support on P2P mobility emissions were explored. This section shall discuss selected key results and insights from different dimensions of difference. The full tables of results are presented in appendix 3.

6.6.2.1. *Comparing the relative importance of trust and institutional support across scenarios*

Comparing the results from the *high support low trust* scenario and the *low support high trust* scenario demonstrates the relative importance of these two key uncertainties for each adopter group. The differences between scenarios 2 and 3 across adopter groups are presented in Figure 16. This figure displays just the substitution effect. The suppression and shedding effects follow a similar pattern to the substitution effect. The full table of results are presented in appendix 3.

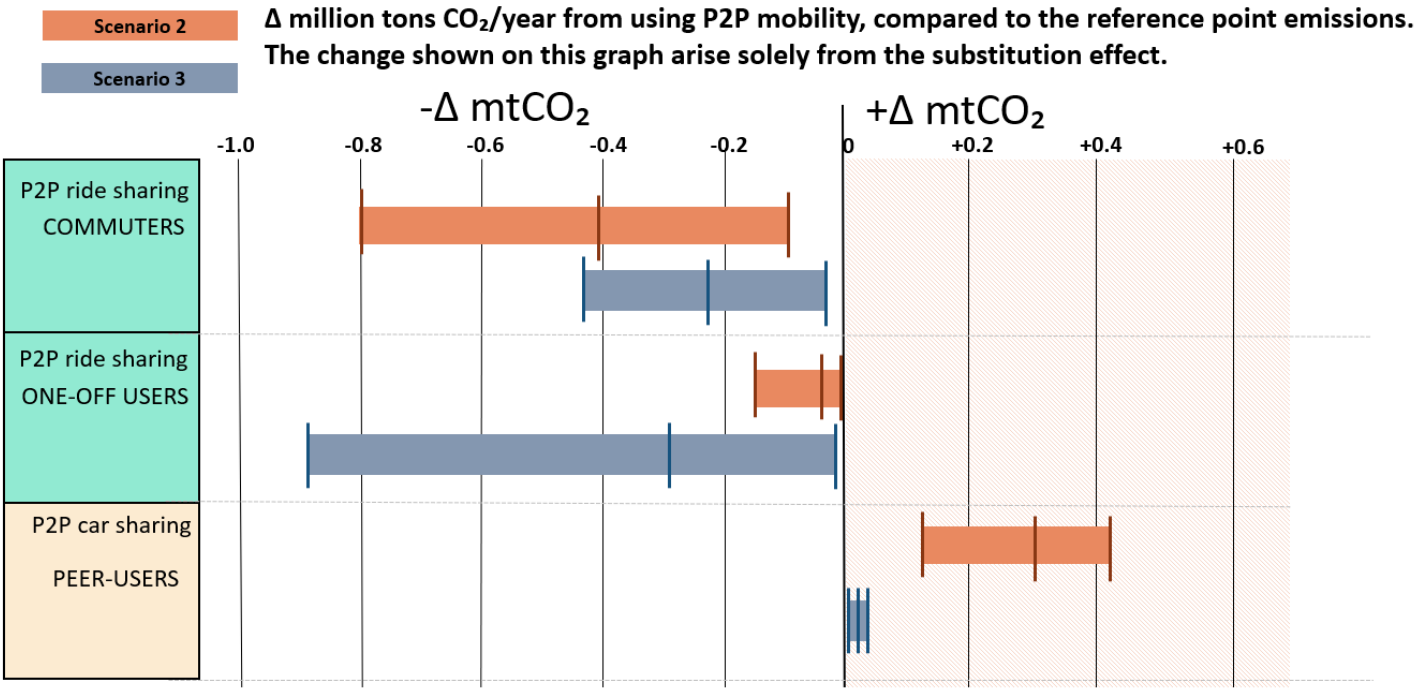

Figure 16: The change in emissions arising from the substitution effect in the high support low trust scenario and the low support high trust scenario.

Commuters

Commuters have larger emissions reductions from the *high support low trust* scenario than the *low support high trust* scenario from the substitution effect. For the commuters, institutional support is more important than trust in determining the emissions impacts of P2P ride sharing. This increase can be attributed primarily to a higher population of potential adopters who would use P2P ride sharing in a low institutional support and high trust scenario.

For commuters, institutional support can promote the adoption of P2P ride sharing through facilitating finding matches, making commuting by ride sharing more attractive than alternatives, and providing reassurance and familiarity when compared to non-workplace based P2P rideshare schemes. The requirements of trust in person are lessened for commuters since they are travelling with other members of the same community. In addition, the requirements of trust in the platform are lessened for workplace-based schemes given that the workplace is regarded as the face of the platform and there is a level of familiarity and comfort therein.

One-off users

The one-off users had the largest difference in substitution effect emissions between the high support low scenario and the *low support high trust* scenario. This shows that trust is more important than institutional support for one-off users, and futures which have high trust result in higher emissions reduction potential. The larger emissions reductions in the *low support high trust* scenario is attributable to numerous factors. At the adopter level, higher trust was assumed to result in increased frequency of use, longer journey distances, and higher occupancy rates, as people feel comfortable and trusting to use P2P ride sharing for one-off journeys. Additionally, the estimated adopter population is larger for the *low support high trust* scenario than the *high support low trust* scenario.

The one-off users are the adopter group which has the lowest requirement for institutional support. At present (and under the behaviourally realistic estimates) there is very little institutional support for one-off ride sharing. Many of the support mechanisms in place for the commuters (including designated workplace parking, free or discounted workplace parking, and the encouragement to commute by rideshare as part of workplace sustainability goals) are not applicable to one-off users. For one-off users, the *low support high trust* scenario could therefore be regarded as a “high-trust” alternative to the behaviourally realistic estimates.

P2P car sharers (peer-providers and peer-users)

The substitution effect for P2P car sharing peer-users results in an emissions increase, rather than a decrease. This increase is larger for the *high support low trust* scenario than for the *low support high trust* scenario, showing that having higher levels of institutional support is more important than trust for the diffusion of P2P car sharing. The difference in emissions observed between these two scenarios is a factor of both population size and use characteristics. In scenarios with high institutional support, adopters are more likely to use P2P car sharing more often. At the population level, there are likely to be more potential adopters willing to use P2P car sharing.

P2P car sharing peer-providers also have a higher anti-shedding and anti-suppression effect in the *high support low trust* scenario than the *low support high trust* scenario. This difference is primarily caused by a higher potential population of P2P car sharing providers in the *high support low trust* scenario. The diffusion of P2P car sharing, from both peer-providers and peer-users' perspectives', is more heavily influenced by having high institutional support than high trust. High institutional support could make P2P car sharing a more attractive mode than alternatives, and alleviate concerns and barriers around insurance legalities, vehicle protection, and parking restrictions for P2P car share vehicles.

6.6.2.2. *Comparing behaviourally realistic and the high support high trust scenario emissions impacts*

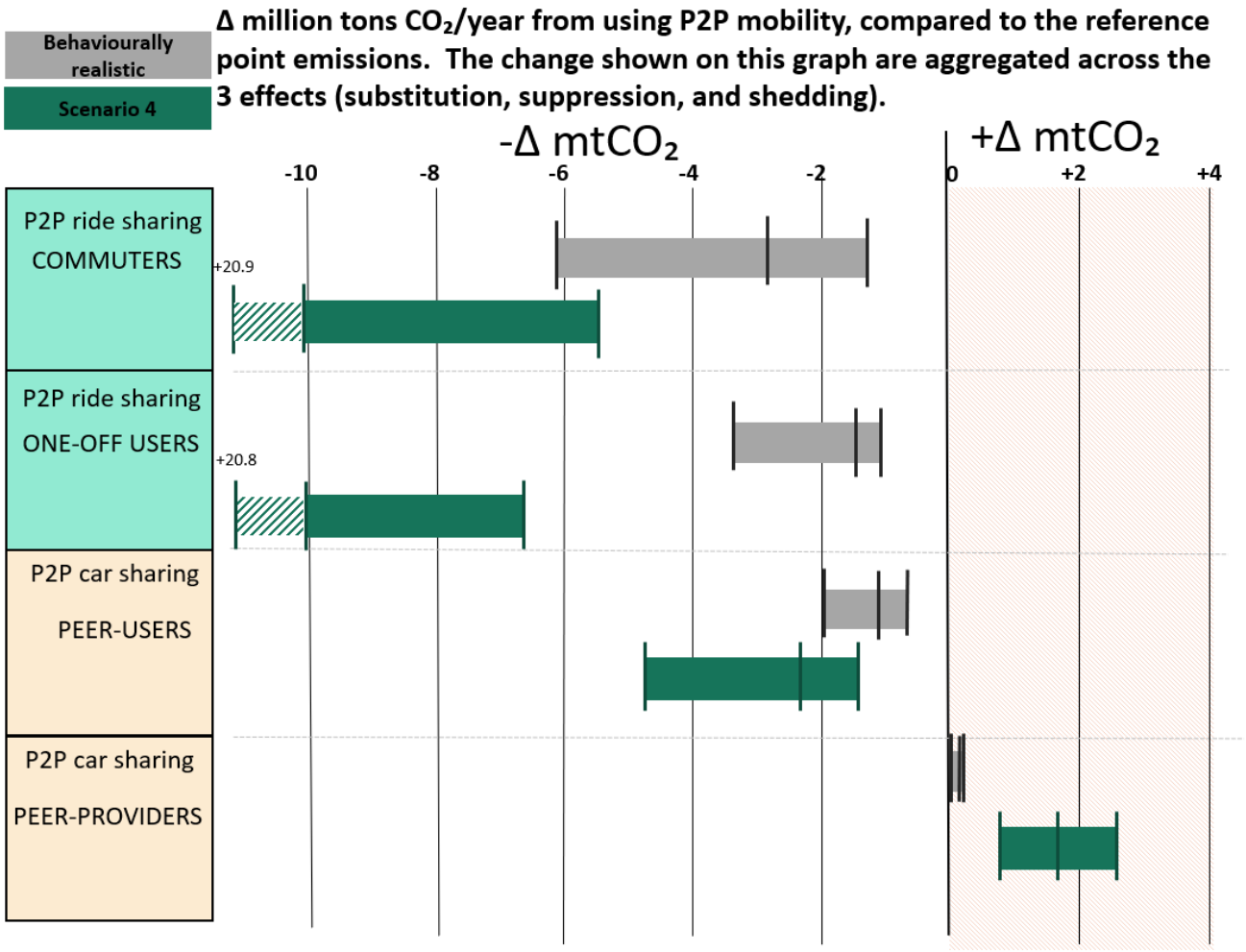

Figure 17: The behaviourally realistic change in emissions compared with the change in emissions in the high support high trust scenario for all adopter groups. The combined change from all three effects is shown.

Across all adopter groups, the *high support high trust* scenario resulted in the highest emissions reductions. This is universally the best-case scenario. Comparing the *high support high trust* scenario with the behaviourally realistic estimates in section 6.5.6 shows the magnitude of the impact that high trust and high institutional support futures could have on emissions.

The adopter group which had the smallest difference between the behaviourally realistic and the *high support high trust* scenario emissions was the peer-users of P2P car sharing. This shows that trust and institutional support are less important for the future adoption of P2P

car sharing for peer-users. On the other hand, the peer-providers of P2P car sharing had the largest difference between their behaviourally realistic and the *high support high trust* scenario emissions. These emissions arise solely from the anti-suppression and anti-shedding effects, resulting in an emissions increase. However, although the relative difference for the peer-providers was the largest, the actual amount of emissions is still the lowest across all the adopter groups. This is attributed to the comparatively smaller population size of peer-providers.

The potential emissions reductions under the *high support high trust* scenario for the one-off users and the commuters were much more similar than the behaviourally realistic estimates for these two adopter groups. While the *high support high trust* scenario assumptions caused emissions reductions, which were approximately four times larger than behaviourally realistic estimates for the commuters, for the one-off users' the *high support high trust* scenario emissions reductions were approximately seven times larger than their behaviourally realistic estimate. A future with increased trust and increased institutional support would have a larger relative reduction in emissions for one-off users than for commuters. At present, there is some institutional support for commuters, whereas institutional support for one-off users is almost non-existent in the UK compared to other countries (for example, the dedicated use of carpool lanes, priority parking in city centres if registered with a P2P ride sharing platform, and financial incentives exist in other countries but not in the UK (see Chamoro-Obra and Fukuda, 2020)). Furthermore, the presence of a workplace-based scheme used exclusively by people who work for the same organisation can mean that the levels of trust (in particular trust in person) required may be lower. As found in chapter 5 commuters are more likely to be more inherently trusting of their colleagues than of strangers.

Despite the differences in magnitude, there are clear emissions benefits across all adopter groups in a high trust and high institutional support future (with the exception of P2P car sharing peer-providers). Recommendations for how to support a high trust and high institutional support future to maximise the potential emissions benefits are presented in chapter 7.

Across almost all scenarios, the anti-suppression and anti-shedding effects from the peer-providers are smaller than the suppression and shedding effects from peer-users. This means that, for every scenario, there is a net-emissions decrease from the diffusion of P2P car sharing. The exception to this pattern is in the *low support low trust* scenario, where the

anti-shedding effect is slightly larger than the shedding effect. In a low trust and low institutional support future, there is an increase in emissions when considering the shedding effect alone. The emissions arising from peer-providers purchasing additional vehicles is larger than the emissions from peer-users getting rid of their cars. In this scenario there is very little motivation for peer-users to shed their existing vehicles. However, when the impacts are aggregated, there is an overall reduction in emissions.

The *high support high trust* scenario offers the greatest emission reduction when all the effects are aggregated. This is despite the largest positive substitution effect and anti-suppression and anti-shedding effects. This example highlights the importance of considering overall impacts across different effects, rather than drawing conclusions based on a single effect.

6.7. Discussion

This chapter expected to find a combination of emissions reductions and increases, caused by the interplay between effect, counterfactual, and adopter group. Overall, the adoption and diffusion of P2P mobility can reduce emissions. At the population level, the behaviourally realistic estimate predicts the greatest emissions reductions generally arise from the suppression effect. The exception is for the commuters, where the high frequency of use and comparatively high behaviourally realistic population means that the greatest emissions reductions come from the substitution effect. The interplay between the effects became evident when exploring the scenarios. The scenario analysis (and to an extent the population-level analysis) demonstrated the importance of considering the aggregate impacts of the effects across adopter populations. This was particularly true for P2P car sharing. When the interactions between the three effects for both peer-providers and peer-users were considered together, there was evidence of an overall emissions reduction from the adoption and diffusion of P2P car sharing, despite there being an increase for peer-providers.

Overall P2P mobility innovations can contribute to reduced transport emissions. At the individual level, the adoption of P2P mobility could reduce annual emissions by 70 to 509 kg CO_2e per person annually. This is in line with some previous estimates in the literature (as an example, Nijland and van Meerkerk (2017) estimate reductions of 236 to 392 kg CO_2e per person annually from car sharing). The annual emissions from private cars and taxis in the UK are estimated to be 68 $MtCO_2e$ (Department for Transport, 2021). The adoption of P2P mobility innovations in the UK could reduce emissions by 3 (low estimate) - 11 (high

estimate) $MtCO_2e$ annually under the behaviourally realistic scenario. In other words, adopting P2P mobility innovations could reduce annual emissions from private cars and taxis by 4 – 16%.

Some of the hypotheses presented at the start of this chapter are supported by the data. Specifically, P2P car sharing providers increase rather than decrease emissions. This is caused by the anti-suppression and anti-shedding effects and demonstrates the importance of considering multiple effects when assessing the impacts on emissions of P2P mobility. Similarly, the data support the hypothesis that P2P ride sharing leads to an emissions reduction through the substitution effect. However, this hypothesis is supported at the population level where the impacts of different counterfactuals lead to an overall reduction in emissions, while at the scale of the individual adopter the direction of emissions impacts (increase or decrease) is dependent on what P2P mobility is substituting for. It was expected that high-trust scenarios would have a greater impact on emissions for P2P ride sharing, and high-institutional support scenarios would have a greater impact on emissions for P2P car sharing. The data support both of these expectations.

The emissions impacts of P2P mobility are affected by numerous uncertainties. At the individual adopter level these uncertainties include the emissions effect being calculated, the ways in which adopters typically use P2P mobility, and the counterfactual. At the population level there are the additional uncertainties of the personality and contextual factors which predict adoption. In the scenarios there are further uncertainties around the scenario assumptions. This chapter introduced and explored new uncertainties at each analytical scale building upon the previous scales.

However, quantifying each of these uncertainties involves inherent assumptions. The assumptions made at the different methodological steps have impacts on the results. At the per-person level, it was assumed that the annual p.km was constant, and that this would be reached through a combination of P2P mobility and other modes. This assumption was carried through all the analytical scales. While this could be the case for commuters, who use P2P ride sharing to make a specific journey, this is unlikely to be the case for the other adopter groups. Yin *et al*. (2018) explored the emissions impacts of rebound effects on increased use of P2P ride sharing. These rebound effects arise where P2P ride sharing is seen as more attractive than alternatives and cause more people to choose travelling by car over public transport and active modes for shorter distances, and people travelling longer distances by car. In their study, the authors estimate that the rebound effects reduce the

potential emissions savings by a third to a half. Similarly, Amatuni *et al*. (2020) found evidence of significant rebound effects which reduce the emissions savings potentials of (B2C) car sharing.

Another limitation of this study is the assumptions made about the use of counterfactuals. While the weighted average of two counterfactuals was used as the reference point for comparisons, a person's choice of alternative modes of transport is likely to vary depending on numerous factors, including financial costs, convenience, reliability, journey time, availability, as well as personal habit (Donald *et al*., 2014). The decision was made to calculate the weighted average of counterfactuals rather than treat each counterfactual as separate reference points. Under this approach the distinctions between the different counterfactuals, and their different emissions impacts became less clear. However, as the overall impact on emissions from P2P mobility innovations will be the cumulation of different impacts in different contexts, the approach taken in this chapter to estimate the population level impacts using weighted averages are regarded to be appropriate.

The diffusion of P2P mobility is constrained by personal, institutional, and contextual factors. The scenarios in this chapter explored only two key uncertainties using a simple 2x2 matrix. In the real world there are a magnitude of uncertainties which shape the future adoption and diffusion of P2P mobility. Even in a future with high trust and high institutional support, there are still numerous other factors which limit the diffusion of P2P mobility. The technical potential population estimates will never be realised. This is demonstrated when comparing the emissions reductions in the *high support high trust* scenario with the technical potential population estimates. The technical potential population estimates are roughly two to three times larger for all adopter groups than the *high support high trust* scenario estimates.

Including institutional support as a key uncertainty also raises the question about who decides and who drives adoption of P2P mobility in the workplace. The diversity of workplace incentives, as both carrots and sticks, mean that the answer to this question is likely to differ based on the specific workplace.

The COVID-19 crisis has had, and continues to have, an impact on the diffusion of P2P mobility. While the scenarios explore the impacts of trust and institutional support based on pre-COVID assumptions, both key uncertainties have been heavily impacted by COVID. As explored in the previous chapter, there was (and at the time of writing still is) a marked decrease in the use of P2P mobility due to national lockdowns, changing work patterns,

institutional discouragement, and interdictions of P2P ride sharing (for commuters), unwillingness to share space with others, and unwillingness to share personal goods and products with others, among other factors. It could be suggested that, as a result of COVID-19, there have been systemic reductions in trust in others (Meenakshi, 2021) and institutional support for shared mobility. In other words, there has been a shift towards the lower left quadrant of the 2x2 future space, as shown in Figure 18. It could be suggested that due to COVID-19, we are currently in the *low support low trust* scenario.

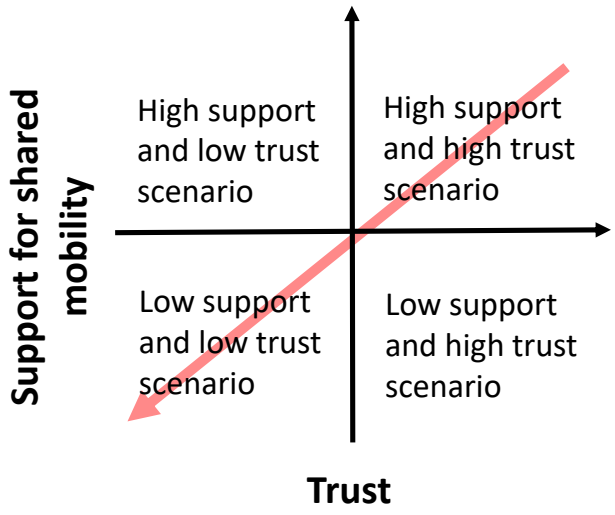

Figure 18: The impacts of COVID-19 on trust and institutional support are represented by the red arrow.

However, in the case of P2P car sharing there is evidence of increased use as a direct response to the COVID-19 pandemic (see chapter 5). This was due to people's desire to avoid public and shared transport. Adopters placed increased importance on autonomy and privacy. Trust and institutional support in the context of P2P car sharing were not as significantly impacted compared to P2P ride sharing. Robolek *et al*. (2021) predict that the increase in adoption of car sharing caused by COVID-19 will continue after the pandemic. They base this assumption on the economic impacts of COVID-19 and the increased need for "cost-flexible" mobility approaches. This also demonstrates how there are other dimensions which have had a direct impact on the adoption and use of P2P mobility innovations during COVID-19 beyond trust and institutional support.

Finally, P2P mobility innovations must be framed as long-term and viable alternatives to private car ownership and exclusive use. While the previous chapter explored the importance of trust and institutional support on the adoption of P2P mobility at the

individual level, this chapter has demonstrated the importance of trust and institutional support if the diffusion of P2P mobility innovations at the population level is to have an impact on reducing emissions. Therefore, P2P mobility platforms must focus on developing trust mechanisms, and where applicable (e.g., for workplace-based schemes), enact supportive policies, creating workplace practices which encourage P2P mobility. These actions will contribute to P2P mobility being regarded as a viable alternative to private car ownership and use, for both peer-service users and peer-service providers. Specific recommendations to this end are provided in the next chapter.

However, it is important to highlight that P2P mobility differs from other B2C shared mobility business models, which are centred on challenging the notion of private car ownership through providing access. The long-term success of P2P mobility depends on having adopters who do own and share private cars, rather than completely discouraging private car ownership. Changing the ways in which private vehicles are used to enable shared mobility is where the potential success and emissions benefits of P2P mobility lies. However, it is important to reiterate that there needs to be a balance between peer-providers and peer-users to achieve the maximum potential benefits. In this way, there is no "one-size-fits-all" policy approach regarding the universal disincentivisation of car ownership. This shall be further explored in chapter 7.

Chapter 7: General discussion

This chapter assesses the extent to which the overall research aim of this thesis has been met. The key findings from the three empirical research chapters are summarised and the contributions of this thesis to scientific knowledge are presented. The cross-chapter and cross-research question implications of these findings are discussed. These implications are used to make recommendations to support the diffusion of P2P mobility innovations and to maximise the potential emissions reductions impacts. Finally, the limitations of this study are recognised and potential directions for future research are presented.

7.1. Summary of key findings

7.1.1. Assessing the overall thesis aim

The aim of this thesis was ***to explore the adoption and diffusion of P2P mobility innovations and to assess the potential impacts on emissions***. The three empirical chapters answered specific research questions which addressed the overall thesis aim. In general, numerous contextual, personality, and institutional factors were found to impact the adoption and diffusion of P2P mobility innovations. Furthermore, the adoption of P2P mobility innovations could reduce emissions by 3-11 $MtCO_2e$ annually at the national level, representing 4-16% of annual emissions from private cars and taxis.

The rest of this section will summarise the key findings from the three research chapters.

7.1.2. Who uses P2P mobility innovations?

Through in-depth surveys with adopters of P2P car sharing, adopters of P2P ride sharing, and non-adopters, chapter 4 identified distinguishing socioeconomic characteristics of P2P mobility adopters. Adopters of P2P mobility in general tend to be younger, have higher levels of education, have higher rates of employment, and have higher rates of car ownership than the general population. These findings support Rogers (2003) generalisations about the socioeconomic status of early adopters, and some of the previous research into the adopters of P2P car sharing and P2P ride sharing (see Shaheen *et al*., 2018; Shaheen *et al*., 2017). Chapter 4 explored three further personality variables which have been suggested in the literature to be important predictors of the adoption of P2P mobility: technophilia, sociableness, and trust. In line with Rogers (2003) generalisation, adopters of P2P mobility are more technophilic than non-adopters. This is expected given the reliance of P2P platforms on mediating technologies. Adopters of P2P mobility innovations are no more social than non-adopters. Adopters of P2P ride sharing are more trusting than non-adopters, however there are no differences between how P2P car sharing adopters and non-adopters

perceive trust. These results indicate that trust potentially plays a different role in the adoption of P2P ride sharing compared to P2P car sharing. This relationship between trust and adoption of P2P mobility was further explored in chapter 5.

The survey analysis also identified four distinct, heterogenous groups of adopters in the sample. P2P ride sharers can be split into commuters and one-off users. Commuters are typically older, have a higher income and have greater financial stability than one-off users. Commuters typically live in a household with access to a car, while one-off users do not. P2P car sharers can be split into peer-providers and peer-users. Peer-providers typically have higher incomes and are more likely to live in households with multiple cars than are peer-users. While some studies do draw direct comparisons between peer-providers and peer-users of P2P car sharing (see Wilhelms *et al*., 2017, Münzel *et al*., 2019), there are no known studies which compare different types of P2P ride sharing user, and from both a peer-user and a peer-provider perspective. The findings from this chapter characterising the distinct groups of users are a novel contribution to current understanding of adopters of P2P mobility. The identification of these different adopter groups was carried through the two subsequent empirical chapters. This allowed for the research questions to be explored in the unique framing of the identified adopter groups, contributing to more detailed and specific insights.

This chapter also explored the adopters' and non-adopters' perceptions of the attributes of P2P mobility innovations, as predictors of the diffusion rate of these innovations.

To summarise, the findings from this chapter indicate that, in some regards, adopters of P2P mobility innovations are different to the general population. Identifying the ways in which adopters differ to the general population provides crucial insights into the diffusion potential of P2P mobility. Furthermore, identifying that there are socioeconomic and personality differences between types of adopters of the same P2P mobility innovation is a significant academic contribution. There is a tendency in the literature to treat early adopters as a relatively homogenous group, sharing key characteristics when compared to the other four "ideal types" of adopter (see Rogers, 2003). The results from this chapter argue that the reality of adoption is much more nuanced. Different adopter profiles have distinct motivations, contexts, and barriers.

7.1.3. What is the role of trust in the adoption of P2P mobility innovations?

A series of focus groups were designed and conducted with adopters who fit the distinct profiles identified in the previous empirical chapter. These focus groups explored the role of

trust in the adoption of P2P mobility innovations, using the conceptual framework of the dimensions and targets of trust proposed by Hawlitschek, Teubner and Weinhardt (2016). This conceptual framework provided novel insights into the role of trust in P2P mobility innovations through examining the different dimensions and targets of trust from the perspectives of both the peer-user and peer-provider. Current literature on trust in P2P mobility tends to consider only one perspective (most often the peer-user for P2P ride sharing and the peer-provider for P2P car sharing). Furthermore, current literature tends to focus either on trust in other users (peers), or trust in the platform. However, chapter 5 revealed that there are differences between how the different adopter profiles perceived the importance of trust in person, platform, and product. These differences emerge from the different business models and the different contexts, motivations, and requirements for the distinct adopter groups.

The ability to find matches emerged as one of the most important manifestations of trust in the platform, for both P2P car sharing and P2P ride sharing adopters. This was a stronger determinant of trust in the platform than the reputation of the platform. This was unexpected and in contrast to previous literature which suggests that the reputation of the platform is the main consideration for potential adopters (see ter Huurne *et al*., 2017). P2P ride sharing users (both peer-users and peer-providers) regarded personal safety as the most important aspect of trust in other users, whereas this was not a main consideration for P2P car sharing adopters. For P2P car sharers trust in the platform was more important than trust in other users. This supports Mohlmann's hypothesis that trust in the sharing economy is a two-tiered construct (Mohlmann 2016) and demonstrates how trust in the platform enables trust in other users. Furthermore, the perception that mobility platforms are self-regulating could also be regarded as an example of two-tiered trust; adopters trust that the other users will be held accountable to the platforms' standards.

Institutional support emerged as an important factor from the focus groups in shaping adopters' perceptions of P2P mobility. In particular, high institutional support facilitates adoption. Using the framing of DOI, high institutional support increases perceptions of the relative advantage, and the compatibility of P2P mobility innovations with the experiences and needs of adopters. Similar to trust, the perceptions and requirements for institutional support differ for the different adopter groups. In general, peer-providers of both P2P car sharing and P2P ride sharing have greater requirements of institutional support than do peer-users of these innovations. This chapter developed theoretical understanding and provided novel knowledge of these concepts. The insights from this chapter about the

importance of trust and institutional support informed the development of the future scenarios in chapter 6.

7.1.4. What are the potential emissions impacts of using P2P mobility innovations?

The current literature exploring the sustainability benefits of P2P mobility tends to focus on sustainability-driven motives for participating in the sharing economy, and to hypothesise about potential sustainability benefits at a meta level (Gossen *et al*., 2019). There has been little research empirically exploring the sustainability impacts of P2P mobility (ibid). This chapter addressed this research gap through quantifying the current and potential emissions impacts of the adoption and diffusion of P2P mobility innovations. To this end, a three-step approach was taken.

The current impacts of P2P mobility at the individual level were estimated, and it was found that the largest emissions impacts for each adopter group came from different effects. For commuters, the largest emissions impacts came from the substitution effect (i.e., commuting by P2P ride sharing instead of other modes including single-occupancy vehicles). For one-off users and P2P car sharing peer-users the largest emissions reductions came from the suppression effect (i.e., forgone vehicle purchases enabled by using P2P mobility). Peer-providers of P2P car sharing exhibit an anti-suppression and anti-shedding effect and their personal emissions increase. Identifying these differences has implications for practice, and recommendations of how platforms can use these findings to maximise potential emissions reductions will be presented later in this chapter.

Insights from chapter 4 and chapter 5 about the characteristics of adopters and the roles of trust were used to estimate the behaviourally realistic population of each adopter group and the emissions impacts at the population level. There are larger behaviourally realistic population estimates of P2P ride sharers than P2P car sharers. This results in larger emissions reductions from P2P ride sharing than P2P car sharing. At the population level, the emissions increases from P2P car sharing peer-providers are negated by the emissions reductions from P2P car sharing peer-users. This demonstrates the importance of estimating overall emissions impacts using numerous effects.

Finally, trust and institutional support emerged as two key dimensions of uncertainty shaping the adoption and diffusion of P2P mobility innovations in chapter 5. A 2x2 matrix was developed to explore future scenarios along these dimensions of uncertainty. For both P2P car sharing and P2P ride sharing the greatest emissions reductions occur in a high trust and

high institutional support future. However, the magnitudes of the impacts of increasing levels of trust and institutional support differ for the different adopter groups. Mechanisms which support a high trust and high institutional support future are proposed later in this chapter.

The variation in emissions estimates in this chapter demonstrate the inherent complexity associated with quantifying the emissions arising from P2P mobility use. These estimates are dependent on specific assumptions.

7.2. Implications for the future of P2P mobility innovations

The aim of this thesis was to explore the adoption and diffusion of P2P mobility innovations and to assess the potential impacts on emissions. This section will reflect on the research aim of this thesis, and how the three empirical research chapters have helped to address this aim. At the end of each empirical chapter the implications of the findings were discussed to some extent. In this section the wider implications of the thesis findings are presented, with a focus on the cross-chapter insights.

7.2.1. The diffusion potential of P2P mobility innovations

It is estimated that 0.55% of UK adults (roughly 250000) have used ride sharing (Office for National Statistics, 2016). Existing literature exploring people's willingness to list their vehicle on P2P car sharing platforms (potential peer-providers) range from 50% of the adult population (Beria *et al*., 2017; Frost and Sullivan, 2015), to 19% of the adult population (Wilhelms *et al*, 2017). However, the only known study which quantifies the potential market saturation of P2P car sharing estimates that P2P car sharing will ultimately be adopted by 10% of the adult population, including both peer-providers and peer-users (Scholl and Gossen, 2018[12]).

The differences between the projected participation rates and the percentage of the population who state that they would hypothetically be willing to rent their car out highlight that there are additional barriers to adoption. This thesis estimates that the behaviourally realistic adoption rate of peer-providers of P2P car sharing is around 0.2% of the UK adult population (chapter 6). This estimate considers the requirement of trust (in platform and in person) to encourage a potential adopter to rent out their personal vehicle. This comparatively smaller behaviourally realistic population supports the findings by Valor

[12] This estimate is for Germany. There are no known estimates for the UK at the time of writing.

(2020), who found that the existing trust-building mechanisms do not fully alleviate the anticipated stress that potential P2P car sharing providers feel when considering joining a P2P car sharing platform. This finding was also supported by the focus groups, which found that peer-providers who rent their personal, private car (instead of a "fleet" car they own) feel anxious and expect the peer-user to take care of it. Valor (2020) also proposes that the anticipated stress that potential peer-providers feel towards renting their personal cars are communicated among their social networks, and thus can negatively impact the diffusion of the innovation in a social system.

Using the framing of DOI, concerns around trust could be regarded as a relative "disadvantage". They could also result in lower perceptions of the compatibility and increased perceptions of complexity of P2P mobility innovations. This could influence people's decisions not to adopt P2P car sharing. It emerged from the focus groups in chapter 5 that almost all peer-providers of P2P car sharing who were renting out their personal cars had had negative experiences, and for almost half of this group they had stopped renting out their car on P2P car sharing platforms. This has subsequent negative implications for the diffusion of P2P car sharing. In DOI early adopters are pivotal in spreading trusted information and knowledge about the innovation among their social networks. However, negative experiences and perceptions of the innovation can hinder this process.

Potential adopters of P2P mobility innovations need to clearly understand and have positive perceptions of the attributes of P2P mobility. The research presented in this thesis suggests that the strongest perceived benefits of P2P mobility innovations are the potential financial benefits.

For commuters who use P2P ride sharing, and peer-users and peer-providers of P2P car sharing there are additional dimensions of the relative advantage which are important in their decision to adopt P2P mobility. However, the value proposition for peer-providers of one-off P2P ride sharing is less strong. By offering potential rides and facilitating a successful match peer-providers lose their independence and autonomy. These are recognised as key attributes of private car ownership and use (Goodwin, 2010). Furthermore, potential peer-providers for one-off journeys have trust concerns, especially regarding their personal safety and allowing strangers to travel in their vehicle with them. This results in a comparatively lower diffusion potential and fewer potential peer-providers of one-off ride sharing when compared to potential peer-users.

There do not need to be equal numbers of peer-providers and peer-users to reach maximum diffusion potential. P2P ride sharing can operate on a 1:4 ratio (with one driver to four passengers) and P2P car sharing platforms in the UK typically have one peer-provider per fifty peer-users (personal correspondence with P2P platform representative, 2019). Understanding how the "critical masses" for the different adopter groups compare can help platforms focus their efforts on certain peer-roles. This could particularly be the case for P2P car sharing, where the difference in peer-provider and peer-user numbers is much greater than for P2P ride sharing. Having demand match supply (albeit on different ratios) is vital to the diffusion of P2P mobility innovations. A successful P2P mobility transaction is dependent on at least two people performing different and complementary peer-roles. Platforms need to ensure that they have enough people performing each of the two peer roles to be successful. The results from the population estimates in chapter 6 showed that, for commuters using P2P ride sharing, there are estimated to be approximately three to four times more potential peer-providers in a behaviourally realistic scenario. However, while this ratio is the inverse of what is required for P2P ride sharing, this thesis found in chapter 5 that many commuters form so-called commuting "bubbles" and share and rotate the role of driver and passenger. Therefore, this discrepancy would still support the diffusion of P2P ride sharing.

In the case of P2P car sharing, the population estimates for the behaviourally realistic population in chapter 6 proposes that there could be potentially eight times more peer-users than peer-providers. This is well below the current ratio in the UK of 50:1. To increase the number of potential peer-users who can make use of the supply of vehicles current car-owners would need to shed their current vehicle. This would result in a higher population of car-free adults with driving licenses who match the other sociodemographic characteristics of potential peer-users. The shedding of a vehicle and subsequent use of P2P car sharing was also found to have a larger emissions reduction than the substitution effect alone. A potential peer-user who sheds a vehicle and subsequently uses P2P car sharing would increase the ratio of peer-users to peer-providers. As well as reducing emissions from the perspective of the peer-user, this could also have implications for the further diffusion of P2P car sharing. Numerous peer-providers who were outside of London stated that they had difficulty gaining enough demand for their vehicles. In the long-term, this could disincentivise potential peer-providers from participating in P2P car sharing if they do not have enough demand and see the value in continuing. Increasing the demand of vehicles outside of London should be a priority to facilitate the diffusion of P2P car sharing. However,

it is important to note that this finding contradicts the proposition by Münzel *et al*. (2019) and Meelen *et al*. (2019) that P2P car sharing is not constrained to urban and semi-urban areas. While they propose that P2P car sharing can occur "anywhere a car owner lives" (p,138) this thesis has found evidence that, currently in the UK, this is not the case given the need for supply to match demand.

Wilhelms *et al*. (2017) propose that the lack of peer-providers is hindering the diffusion of P2P car sharing platforms in the context of Germany. The findings from this thesis in the UK support Wilhelms *et al*.'s finding and show that peer-providers typically have more concerns about renting their personal vehicles and require higher trust than do peer-users. Platforms should prioritise trust-building mechanisms for peer-providers to incentivise providers adoption. The results from chapter 5 indicate that partnering with a mainstream insurance company is a pathway to achieving this. Reducing trust concerns among potential peer-providers is vital as it hinders the potential diffusion of P2P car sharing and limits the potential emissions reductions from the adoption of this innovation.

In the context of P2P ride sharing, there is greater diffusion potential for commuters than for one-off users. Workplace based schemes can be regarded as an example of an authority innovation decision process in the framing of DOI, and it is recognised that authority innovation decisions have the fastest rates of adoption (Rogers, 2003). Furthermore, workplace based P2P ride sharing schemes can facilitate stronger perceptions of the attributes. Specifically, joining a workplace-based scheme can reduce the perceived complexity associated with P2P ride sharing, as the features and benefits are perhaps more apparent to potential adopters. There may also be stronger perceptions of the relative advantage. While the surveys in chapter 4 revealed that the financial benefits of P2P ride sharing were the most important perceived benefit for P2P ride sharers, the focus groups revealed other benefits which could also be framed as relative advantage. Specific examples include the benefits of having designated parking spaces or reduced parking costs, and the pleasure from not commuting alone and having others to share the journey (and often the perceived "burden" of driving). These advantages of P2P ride sharing are not applicable in the context of one-off users, where the main perceived advantages for both peer-providers and peer-users are financial. Workplace based schemes could also increase perceptions of the observability (through seeing other users and the benefits of using P2P ride sharing), trialability (through being able to trial P2P ride sharing in a perceived "safer" and easier context), and the compatibility (through aligning with workplace cultures and norms and in line with workplace policies).

Workplace based P2P ride sharing schemes can facilitate trust-building between adopters and may contribute to a sense of community. Workplace based schemes demonstrate the suggestion by various authors, including Amirkiaee and Evangelopoulos (2018) and Ma and Hanrahan (2020), that P2P ride sharing is more likely to be adopted where the members are part of an existing community. Being part of a community alleviates some of the concerns in trust in other people. None of the commuters who used P2P ride sharing for commuting had ever done so in a one-off context, with many respondents citing concerns about trust as their primary reason why.

The results from chapter 4 and chapter 5 reveal how the perceptions of the attributes and trust are vital to the diffusion of P2P mobility innovations. Furthermore, the decision to use P2P mobility innovations is context dependent. Tikoudis *et al*. (2021) propose that P2P ride sharing is spatially dependent. While sprawled and car-dependent areas could confer the greatest potential emissions reductions through P2P ride sharing, low population densities and the strong preference for private car ownership and use limits the diffusion of P2P ride sharing in these environments. On the other hand, the high population density of cities could facilitate the diffusion of P2P ride sharing and make it easier finding matches. However, journeys are likely to be shorter and if the city has a public transport network emissions are more likely to increase.

Aside from the need to find appropriate matches, there were both one-off users and commuters who felt they did not have a choice in their decision to adopt P2P ride sharing. However, this took different forms. For one-off ride sharers, particularly peer-users, some adopters feel "forced" to use P2P ride sharing because there are no suitable alternatives within their financial budget. These adopters have negative perceptions of the attributes of P2P ride sharing, challenging Rogers' expectations and the proposed mechanisms through which diffusion can be accelerated. Furthermore, for these adopters' trust was less of a barrier to adoption. On the other hand, some commuters similarly feel "forced" to use P2P ride sharing by their workplace. Here the decision to adopt is taken at the institution level and not the individual level (an authority innovation-decision process). This could also result in some adopters having negative perceptions of the attributes of P2P ride sharing. These two examples highlight how mobility choices are highly context-dependent, and it is vital to consider the unique contexts of adopters when assessing the diffusion potential of P2P mobility innovations.

7.2.2. P2P mobility in COVID and post-COVID world

The empirical research in chapters 5 and 6 was conducted in 2020 and 2021, against the backdrop of the COVID-19 pandemic. This thesis has demonstrated how both trust and institutional support are vital to the adoption and diffusion of P2P mobility innovations. However, both of these key dimensions have been heavily impacted by the COVID-19 pandemic.

The different estimates of P2P car sharing and P2P ride sharing adoption in a COVID-19 and post-COVID-19 world are caused by the increased value placed on privacy and autonomy in current times. Understanding how the attributes of these different P2P mobility innovations are valued in a COVID-19 and post-COVID-19 world is important as it has a direct impact on the diffusion potential. P2P car sharing as a business model is less dependent on proximity and in-person interactions than P2P ride sharing. It could be proposed that COVID-19, as a shock event, has accelerated the diffusion of P2P car sharing (as described by adopters in chapter 5). On the other hand, the inherent proximity to others and sharing of personal space associated with P2P ride sharing has caused a decline in use during the pandemic.

The long-term implications of COVID-19 on the sharing economy remain unknown (Hossain, 2021; Mont *et al*., 2021). As demonstrated in this thesis, there are diverse contexts in which P2P mobility innovations are used. Commuters had the largest potential emissions impacts, but also the greatest potential drop in use in response to COVID-19. For commuters who use P2P ride sharing to travel to work, it is unknown how the observed changing work patterns and increased remote working in response to the COVID-19 pandemic will continue in the future. On the one hand, it has been suggested that 82% of commuters in the UK who previously commuted by car planned to do so once COVID-19 restrictions had lifted (Harrington and Hadjiconstantinou, 2022). On the other hand, there is evidence that remote and hybrid working models could become “the new normal”, and lead to systemic changes in commuting (PwC, 2022). Even if part-time office work returns and there is a return towards institution-supported commuting by P2P ride sharing, it may be more difficult to coordinate times and days with potential matches. These contexts shape the diffusion potential of P2P ride sharing beyond the key dimensions of trust and institutional support explored in this thesis.

Understanding the long-term implications of COVID-19 on the adoption and diffusion of P2P mobility innovations is further explored as an area for future research in section 7.4.

7.2.3. Maximising the emissions reductions potential of P2P mobility innovations

This thesis found that the adoption of P2P mobility innovations in the UK could reduce emissions by 3-11 $MtCO_2e$ annually under the behaviourally realistic scenario. This represents 4-16% of annual emissions from private cars and taxis. The adoption of P2P mobility innovations in their current form are not likely to make a major contribution to the reduction of transport-related emissions.

However, under the *high support high trust* scenario, the potential emissions reductions could be three to seven times larger. Therefore, to have a larger impact on emissions, strategies need to focus on increasing trust and institutional support. This section will explore ways to maximise the emissions reduction potential of P2P mobility innovations in the context of their current typical use before specific recommendations for platforms and for policy are presented in section 7.3.

From a peer-user perspective, P2P mobility needs to replace single occupancy car journeys, and not public transport use, to maximise emissions reductions from the substitution effect. However, P2P mobility is dependent on different people playing different and complementary peer roles. In the case of P2P ride sharing, adopters who must make a specific journey by car should offer lifts for these journeys to increase the occupancy rates of their vehicles. Commuters who typically drive alone should form commuting bubbles and rotate the roles of driver and passenger (as it was found in the focus groups that commuters valued not having to be the sole driver).

Commuters who use P2P ride sharing typically share and rotate the roles of peer-provider and peer-user within their commuting bubble. Commuters typically have access to a household car and the ability to drive it. In this way, both peer-providers and peer-users could replace the use of a single-occupancy vehicle when they commute together in P2P ride sharing. On the other hand, peer-users of one-off P2P ride sharing typically do not have their own vehicle, and therefore use P2P ride sharing as an alternative to public transport (chapter 4 and chapter 5). The fact that there are such differences between adopter groups of the same innovation demonstrates the internal dimensions of adoption and use, and the inherent complexity in estimating emissions impacts.

Peer-providers of P2P car sharing should not purchase additional cars for the sole purpose of providing them on P2P car sharing platforms. However, it is recognised that this recommendation would potentially reduce the number of potential peer-providers, as this

assumes peer-providers would only rent out their personal car. Chapter 5 revealed that adopters who rent out vehicles which were purchased for the sole purpose of P2P car sharing have fewer concerns around trust and less emotional attachment to their cars compared to adopters who provide their personal car. However, from the perspective of reducing emissions it is important that adopters do not purchase additional vehicles and avoid a movement towards "professionalisation". Furthermore, this is in line with the original vision of P2P car sharing, and harnesses the idle capacity associated with car ownership. Adopters who purchase multiple vehicles for the purpose of renting them on P2P car sharing platforms create additional capacity.

Chapter 6 revealed that in order to maximise the potential emissions reductions from P2P mobility innovations, rebound effects need to be minimised. Rebound effects take different forms for different adopter groups. For P2P car sharing providers, the purchase of additional vehicles for the sole purpose of providing them a P2P car sharing platform is a rebound effect. For one-off users of P2P ride sharing, the additional financial savings when P2P ride sharing is used compared to public transport could result in adopters using P2P ride sharing more frequently.

7.3. Recommendations for practice

This thesis has identified the diffusion potential of P2P mobility innovations and has discussed how the emissions reductions impacts of P2P mobility innovations can be maximised from a theoretical perspective. In this section, clear recommendations are made for platforms and for policy to maximise the potential sustainability benefits.

7.3.1. Recommendations for policy

Policies are needed to support the positive benefits of P2P mobility innovations and restrict the potential negative outcomes.

In the context of commuters using workplace-based P2P ride sharing schemes developing a social norm of commuting by ride sharing can alleviate concerns about trust. This can be achieved through guaranteed car parking spaces, discounted car parking rates, or enforced through only allocating parking spaces to employees who commute by P2P ride sharing. These incentives could be supported from higher institutional levels, for example through government grants and schemes supporting workplaces to promote ride sharing.

There is currently no institutional support for one-off P2P ride sharing in the UK. However, there are examples from other countries where designated High-Occupancy Vehicle (HOV)

lanes on roads encourage adoption of one-off P2P ride sharing (see Shaheen, 2018; Shaheen *et al*., 2018 for case studies from the United States of America). These have been found to have a positive impact on adoption rates (ibid). Further examples of institutional support for P2P ride sharing in other countries include France, where vehicles which are regularly used for P2P ride sharing can receive an exemption card and drive through certain road tolls for free. While the per-person level emissions impacts from one-off users of P2P ride sharing are much smaller compared to the other adopter groups, the potential for one-off P2P ride sharing to significantly contribute to emissions reduction at the population level comes from the high potential population estimates. Therefore focussing on developing support for one-off users is important to increasing the potential population.

Institutional support for P2P car sharing could be achieved by different actors. Policy should support insurers to provide comprehensive and transparent insurance for P2P car sharing. Some cities have free or subsidised parking available for B2C car sharing vehicles to incentivise adoption and use (see Shaheen and Cohen, 2010; Balac *et al*., 2017). There are no known examples of where this policy has been extended to include P2P car sharing vehicles. This is another potential form of institutional support which could incentivise adoption. Particularly in urban areas in the UK where most local councils enforce permit-only parking, allowing P2P car sharing vehicles to park without a permit could incentivise P2P car sharing providers to list their vehicles for rent as they would not risk receiving parking tickets, and could mean that they can park their vehicles when it would not have been permitted otherwise. This could incentivise adoption and facilitate the diffusion of P2P car sharing by providing additional financial incentives to peer-providers and alleviating some of the commonly cited concerns explored in chapter 5. Having designated parking spaces in urban areas for vehicles used in P2P car sharing could also improve perceptions of the observability of P2P car sharing, in line with DOI. However, it is recognised that this could be open to exploitation and could potentially lead to numerous personal cars being listed on P2P car sharing platforms without ever being rented out.

7.3.2. Recommendations for platforms

There are two main approaches to maximising the emissions reductions potential of P2P mobility innovations. First, it is important to increase the potential number of adopters. Second, it is important that P2P mobility innovations are used in ways which lead to the greatest emissions reductions. Recommendations for both approaches are presented in this section. While these recommendations are not explicitly framed in the context of COVID-19,

the key concepts of trust and institutional support which were explored in this thesis have been directly impacted by COVID-19. Therefore, recommendations that increase perceptions of trust and, from the perspective of the platform, increase institutional support, will be relevant and appropriate recommendations in the context of COVID-19 and for a COVID-19 recovery.

To increase the number of potential adopters' P2P mobility platforms should develop trust-building mechanisms. Trust, in both the other users of a platform and the platform itself, is a key driver to the adoption, and continued adoption, of P2P mobility platforms. The findings from this thesis support the suggestion by Mohlmann (2016) that trust is a "hierarchical and two-fold construct" (p7), where trust in the platform has a positive influence on trust in other users. To this end, platforms should prioritise creating and facilitating a trust-worthy environment.

The results from chapter 5 reveal that reviews and ratings of other platform users, although a common digital trust mechanism, are less important than previous research suggests (see Ballús-Armet *et al*., 2014). On the other hand, identity verification and background checks were regarded as mechanisms which can increase trust in other users and provide reassurance around personal safety concerns. Other authors have similarly suggested background checks and identity verifications as a means to increase trust in P2P platforms (see Dill *et al*., 2017; Valor, 2020). These mechanisms were found to be valued by both peer-providers and peer-users in this thesis.

To appeal to potential adopters who may have trust concerns about using P2P ride sharing, platforms should harness social networks for finding matches. This would be particularly beneficial for one-off users of P2P ride sharing as this group had the strongest concerns about personal safety. Commuters who used workplace-based schemes valued the security that comes from being part of a "community" and this facilitated trust between peers. Showing the digital social networks of potential matches may emulate this sense of community for one-off users. Furthermore, using social networks to facilitate finding matches may increase the rate of diffusion through an increased perception of the observability and compatibility of P2P ride sharing. Using digital social networks to find matches may also encourage more potential peer-providers of one-off P2P ride sharing. As previously discussed, the value proposition of P2P ride sharing for potential one-off peer-providers is comparatively weaker. However, if potential peer-providers have a connection to potential peer-users through their networks this may encourage adoption.

In the case of P2P car sharing, the focus groups in chapter 5 revealed a need for transparent and easy insurance policies. Platforms should provide or facilitate insurance for both peer-providers and peer-users. This provides reassurance to both peer-roles in the case of damage to the vehicle and can reduce anticipated stress about the vehicle being damaged (Valor, 2020). The focus groups in chapter 5 revealed that some peer-providers of P2P car sharing had made decisions about which platform to use based on the reputation of the insurance company platforms partnered with. Platforms should ensure that they partner with a reputable insurance provider. As well as being a manifestation of institutional support, this would also alleviate some trust concerns and could reassure adopters and potential adopters. This demonstrates another dimension of reputation in the platform which can have implications for the uptake of P2P mobility on a specific platform.

Platforms can take precautions to provide reassurances to adopters using P2P mobility innovations in the context of COVID-19. Alonso-Almeida (2022) proposed that B2C car sharing platforms should provide "personal kits" to enable adopters to disinfect the vehicle they are using. This measure would be appropriate for P2P car sharing, and the results from chapter 5 indicate that adopters would value this. This could also enable peer-users to feel like they have control and are not relying on someone else to clean and disinfect the vehicle, which was highlighted as a concern in chapter 5.

7.4. Limitations and recommendations for future research

This thesis presented three empirical research chapters each with a separate research question and methods section. The limitations associated with each of the specific methods have been discussed in the relevant chapters. This section will address limitations of the research design as a whole and provide some reflections of the use and applications of the theories and frameworks used in the research chapters. This section will build upon these to provide recommendations for future research.

7.4.1. The role of social influence

While chapter 4 used elements of DOI as a framework to explore the characteristics of adopters of P2P mobility, there are further elements of DOI which were not included in this study. Specifically, the research in this thesis did not thoroughly explore social influence, which DOI frames as a core mechanism in the adoption of innovations. Social influence can take numerous forms, including word-of-mouth (WOM), electronic word-of-mouth (eWOM), social norms, and neighbourhood effects (Vrain *et al*., 2022). These four mechanisms are likely to have different relative importance for different adopter groups. The research in

chapter 5 found that social norms in the workplace were important to the diffusion of P2P ride sharing among commuters. On the other hand, reviews and ratings (as examples of eWOM) were not found to be as important as expected. Further research could explore social influence with a view to further informing differentiated strategies for platforms to maximise potential adoption.

In particular, workplace adoption provides a unique context to research the role of social influence as workplaces manifest positive norms (Appelbaum *et al*., 2007). The research in this thesis explored the adoption of P2P ride sharing for commuting from a "top-down" organisation perspective. Research participants were recruited through various platforms and therefore all participants had experience using organised P2P ride sharing. However, "spontaneous bottom-up self-organisation" (Shoshany Tavory *et al*., 2019, p270) is another form of P2P ride sharing used for commuting. This form of P2P ride sharing can reduce a lack of trust as adopters are more likely to be part of a mutual community (Olsson *et al*., 2019). Future research into the ways in which trust interacts with social norms and social influence could better develop understanding about the adoption and diffusion of P2P ride sharing in institutional contexts.

7.4.2. Reflections on DOI in the context of P2P mobility innovations

Rogers defines an innovation as "an idea, practice, or object" (p12). However, it is difficult to frame some of the attributes of P2P mobility innovations using DOI as a framework. Specifically, it is difficult to define and measure the "trialability" of P2P mobility innovations. P2P mobility platforms are not subscription-based, and it is possible to use P2P mobility just once and then never again. In this example it is unclear whether this would be considered a "trial", adoption, or discontinued adoption under DOI.

Furthermore, in the framing of DOI it is unclear at what point a person would become an adopter of P2P mobility. The surveys in chapter 4 revealed that there are respondents who had signed up to a P2P mobility platform but had not used P2P mobility. This raises the question of whether these people would be considered adopters, where perhaps considering them partial adopters or intentional adopters would be more appropriate.

Additionally, DOI focuses on the individual as the decision maker. However, this thesis has demonstrated that the adoption of P2P mobility can also occur at the institutional level. Where the decision to adopt P2P ride sharing for commuting is taken by an organisation this can result in commuters having negative perceptions of the attributes of P2P ride sharing. The diffusion mechanisms are no longer relevant at the individual level. On the other hand,

this is an example of an authority innovation-decision process (instead of an optional-decision process or a collective-decision process) as the choice to adopt or reject an innovation is made by a small number of individuals on behalf of the social system. The individual does not choose to adopt or reject an innovation, that decision is made for them by someone in a position of authority. DOI proposes that authority innovation-decisions have the fastest rates of diffusion. The research in this thesis supports this, and furthermore the potential population of commuters is higher than any other adopter group included in this thesis (using pre-COVID-19 assumptions).

7.4.3. Long-term impacts of COVID-19

The impacts of the COVID-19 pandemic on trust were explored in chapter 5. The focus groups collecting this data were conducted in the summer and autumn of 2020. For context, the first national lockdown in the UK began to lift on the 23rd June 2020, however "work from home" advice remained in place. There were two additional national lockdowns in November 2020, and January to April 2021. All of the focus groups took place before there was an approved vaccine. It is likely that this impacted respondents' perceptions of trust at the time.

The long-term impacts of COVID-19 on P2P mobility are likely to take different forms. Future research should explore mobility habits, and if and how these have changed as a response to COVID-19. Using the commuters as an example, in the UK 85% of working adults stated that they want to continue a "hybrid" approach to office and home working in the future (Office for National Statistics, 2021). This will undoubtedly have implications for P2P ride sharing adoption. Specifically, it is expected that this may impact the ability to find matches, institutions' perspectives towards commuting by P2P ride sharing, and how potential adopters perceive the relative advantage of commuting by P2P ride sharing. All of these are potential avenues for future research which are vital to understanding the long-term impacts of COVID-19 on the diffusion of P2P ride sharing and the subsequent emissions impacts through changing use behaviours.

At the time the focus groups were conducted the majority of one-off users stated that they were not willing to resume using P2P ride sharing. However, the contexts have since changed as restrictions have eased and vaccinations are available. The long-term impacts that COVID-19 has on trust, and particularly how this has impacted one-off ride sharing, could be explored in future research.

Regarding P2P car sharing, the results presented in this thesis show that COVID-19 could be regarded as a shock event which has accelerated its diffusion. However, it is unknown whether this will continue long-term and if the perceived relative advantage that P2P car sharing had in the context COVID-19 will endure. Further research could be conducted to investigate P2P car sharing in a "post"-COVID-19 world.

7.4.4. Spatial variation in adoption

The results presented in this thesis are relevant in the context of the UK. However, an interesting line of future research would be to explore if the insights from this thesis are different in different geographical settings. Cross-national studies have found that adults in the UK have a lower propensity to adopt P2P car sharing compared to adults in France, Spain, and Japan (Prieto *et al*., 2017), and a lower propensity to adopt P2P ride sharing compared to adults in other European cities. As an example, P2P car sharing was brought to the German and UK markets in 2010 (Münzel *et al*., 2018; Hiyacar, 2021), and Germany and the UK currently have similar numbers of platforms operating (Germany has 3 {Münzel *et al*., 2018}, and the UK has 4 {own research}). Despite both countries having P2P car sharing for the same duration, Germany is currently recognised as having the largest number of users of P2P car sharing in Europe (Robolek *et al*., 2021). Furthermore, the diffusion potential of P2P car sharing in Germany is estimated to be much larger than this thesis estimates (10% of the adult German population (Scholl and Gossen, 2018) compared with 0.2% of the adult UK population (chapter 6)). This difference could be partially attributed to the spatial distribution of P2P car sharing within these two countries. In Germany P2P car sharing successfully operates in semi-urban and rural areas across the country (Münzel *et al*., 2018), whereas in the UK adopters of P2P car sharing outside of London report difficulty in finding suitable matches. This further demonstrates the need for a critical mass of adopters to make P2P car sharing viable. However, there are likely additional contextual and cultural differences between these two countries which may contribute to the observed differences in adoption.

France provides a further interesting example of the successful diffusion of P2P car sharing. In France over 90% of all car sharing is P2P instead of B2C, and there were over 1 million users of P2P car sharing in 2017 (Deloitte, 2017). In contrast, in the UK B2C car sharing is more prominent. One possible explanation for this difference could be the ways in which P2P car sharing platforms are organised in the two countries. In France a national network, *réseau citiz*, is a cooperation of multiple P2P and B2C car sharing platforms. This model

enables peer-users to choose from multiple providers from a single marketplace and could alleviate some of the barriers to finding suitable matches observed with the platform structure in the UK. A second possible explanation could be the different ways vehicle insurance is organised and regulated in the UK and France. In France insured drivers are able to drive any car (unlike in the UK where the car not the driver is insured, and to drive someone else's car typically requires a driver to be added as a "named driver"). This has facilitated a norm of informal sharing of vehicles among one's close social network in France. Indeed, people may be more likely to adopt P2P car sharing if they regularly lend their car to their friends and family informally (Valor, 2020). Therefore, this difference could possibly explain why P2P car sharing in France is much more prominent than it is in the UK.

Further research could compare the specific cultural (including social norms, attitudes, and perceptions), institutional (including policy), and contextual factors of the UK and other countries. This would determine the specific factors hindering the diffusion of P2P mobility in the context of the UK. Identifying these key differences could facilitate the diffusion of P2P mobility in the UK.

7.4.5. Contextualising P2P mobility innovations in the wider low-carbon mobility transition

As discussed in chapter 1, P2P mobility innovations are part of the "three revolutions" of electric, automated, and shared vehicles which represent a sustainable mobility transition (Axsen and Sovacool, 2019). While each of these innovations individually has the potential to reduce emissions when compared to the current regime of automobility, the maximum potential emissions benefits could come from a combination of these three revolutions (Pan *et al*., 2021). It has been estimated that a fleet of shared, automated, electric vehicles could reduce GHG emissions by 70% - 94% compared to privately owned electric vehicles (Sheppard *et al*., 2021; Greenblatt and Saxena, 2015), and could satisfy personal mobility needs with just 9% of the current number of vehicles (Sheppard *et al*., 2021). These estimates of emissions reductions are significantly higher than those found in this thesis. This demonstrates the need for P2P mobility innovations to be combined with alternative technologies (EVs and automation) and as part of a suite of alternatives to the private ownership and use of vehicles.

However, it is impossible to estimate the full potential that these three revolutions could have when combined without understanding the unique characteristics, perceptions, and use-behaviours of potential adopters. Future research could explore adopters the

intersections of these three revolutions. Furthermore, future research could compare P2P car sharing and B2C car sharing, to explore and quantify the differences in emissions between these two business models. One of the main barriers to the adoption of B2C car sharing are the normative beliefs around car ownership (Jain *et al*., 2021; Bulteau *et al*., 2019).

7.5. Concluding remarks

This thesis aimed to understand the extent to which P2P mobility innovations could reduce emissions. To this end, it was found that P2P mobility innovations can contribute to a more sustainable mobility system, reducing CO_2e emissions from private vehicles by 4-16%. However, the direction and magnitude of the impacts on emissions are contingent on specific usage characteristics.

The novel combination of methods, framings, and findings in this thesis cut across multiple research disciplines, and the research presented in this thesis has contributed new knowledge to multiple research communities. Specifically, this thesis has found that there are distinct and diverse groups of adopters of P2P mobility innovations, each with their own sociodemographic characteristics, perceptions of the attributes of P2P mobility innovations, and requirements and perceptions of trust.

As well as speaking to multiple research communities, the findings of this thesis could have implications beyond the specific topic of P2P mobility innovations. In particular, the results in chapters 5 and 6 could have implications for the sharing economy research community in general.

Finally, this thesis has explored and presented key topics related to changing patterns of private ownership and consumption. It is hoped that the knowledge generated through this thesis could help contribute to a more sustainable future.

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Appendix 1: Additional methodological details

1.1. Development of survey question blocks (chapter 4)

1.1.1. Development of travel behaviour and car ownership question blocks

Respondents were asked questions about their travel behaviour and engagement with the P2P mobility innovation, to ascertain what types of journey adopters tend to make, and how using P2P mobility innovations fits in to their normal travel routines. The purpose of this question block was to characterise how respondents engage with the specific innovation. Understanding in what ways people use P2P mobility is important as it can help ascertain if there is heterogeneity among adopters.

1.1.2. Development of use of platform question block

Some of the questions relating to adopters use of P2P mobility innovations were informed by the 2017 version of the CarPlus annual survey of car clubs. Where the question wording was not appropriate for the purpose of this survey, it was adapted – this was particularly the case when designing the version of the survey for P2P ride sharers, as the original version of the survey was specifically for adopters of car clubs (B2C car sharing). Some of the questions in this section were designed specifically for the purposes of the two adopter variants of this survey.

1.1.3. Development of attributes question block

The attributes question block included the five key attributes, as identified by Rogers DOI, which can be used to explain the adoption of an innovation, namely the relative advantage, the compatibility, the complexity, the trialability, and the observability.

The relative advantage of an innovation describes the degree to which it is deemed better than the incumbent which it replaces (Rogers, 2003), where an innovation provides a solution to a particular problem. Users of an innovation perceive its advantages, relative to the needs and wants of the users. Therefore, there is no hard definition of the relative advantage, instead it is often specific to an innovation, and associated user group (Rogers, 2003). The ways in which the relative advantage of an innovation is perceived affect its potential for adoption (Rogers, 2003). Therefore, understanding how adopters and non-adopters compare in their perceptions of the relative advantages of P2P mobility innovations is important, as it can develop an understanding of the diffusion potential of these innovations.

According to Diffusion of Innovations theory, early adopters should perceive the relative advantages of P2P mobility higher than do non-adopters. The decision of which survey items

to include which measure the relative advantage of P2P mobility was informed by prior work conducted by Pettifor *et al*. (2020). Pettifor *et al*. elicited the attributes of a range of low-carbon innovations, as perceived by a sample of the general population. This study identified 34 general attributes from 471 specific constructs, which were then grouped into 11 main attributes. From these lists, the attributes which were appropriate and applicable for the two P2P mobility innovations were used to inform the final 10 survey items measuring the relative advantage.

The survey items which attempt to measure the compatibility, complexity, trialability, and observability scales were taken from an existing 28 – item scale, developed by Moore and Benbasat (1991).

1.1.4. Development of social influence question block

The survey items measuring trusted information sources were taken from Axsen (2017). The survey items measuring opinion leadership were taken from Goldsmith and De Witt (2003).

1.1.5. Development of trust question block

The survey items which attempt to measure trust were taken from an existing instrument which was developed with specific regard to the concept of trust in the sharing economy. As such, the items included attempt to measure trust in both the other users of the platform, and in the platform itself. The original source of these items is Mohlmann (2015).

1.1.6. Development of technophilia question block

The survey items which attempt to measure technophilia were taken from an existing 8-item scale, from Harman *et al*. (2016).

1.1.7. Development of sociableness question block

The survey items which attempt to measure sociableness were taken from an existing 4-item scale, from Amirkiaee and Evanglopoulos (2018).

1.1.8. Development of socio-economic profiles and household characteristics question block

The survey items which ask about respondents' socio-economic profiles follow the wording of the 2018 version of the UK Understanding Society Survey. In the case of the survey items asking about household characteristics, these were taken from a survey instrument developed by Pettifor *et al*. (2018).

1.2. Supplementary information on organising focus groups (chapter 5)

The purpose of this initial step was to ensure that there was enough interest before scheduling a date and time. Next, the interested pool of participants were contacted with two proposed dates and times, and the focus group was subsequently scheduled for the time that was convenient for the most participants. Once a date had been selected, participants were sent an online calendar invitation (in line with the best practice suggested by Forrest *et al*., 2015), instructions on how to join the meeting, and a consent form. Participants were asked to return the consent form in advance, and confirm they could attend the meeting at the specified time. On the day, a reminder was sent to participants, to try to avoid participants forgetting. Only two of the focus groups had "no-show" participants, so this approach could be deemed effective in recruiting and retaining potential participants.

1.3. Estimating emissions impacts (chapter 6)

1.3.1. Estimating emissions impacts

P2P p.km + nonP2P p.km was kept constant. This enables an exploration of the interdependences between the use of P2P mobility and the alternative modes of transport. Adopters are highly likely to use a mixture of P2P mobility and other modes of transport, and therefore this adds further validity to the estimations. This concept is represented visually in Figure 19. In this way, increasing the frequency of use of one inherently decreases frequency of use of the other.

Calculating the potential emissions impacts from using P2P mobility in this way demonstrates a more realistic approach and recognises that people are highly likely to use a mixture of P2P mobility and alternative modes of transport within a year for a fixed annual p.km.

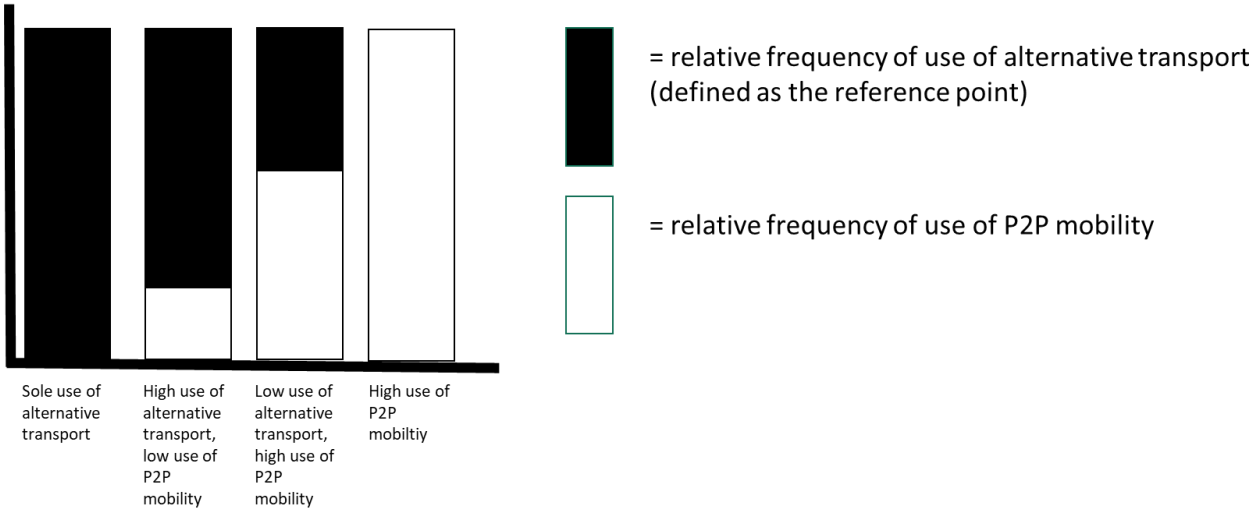

Figure 19: A visual representation of the interactions and interdependencies between the use of P2P mobility and alternative modes of transport (represented by the reference points).

1.3.2. Additional details on estimating the potential and behaviourally realistic populations

It was found during the focus groups that most commuters form so-called "commuting bubbles" with others and rotate the roles of drivers and passengers within this group. Therefore, when estimating the total potential population of commuters, the number of commuters in the UK travelling to work in single-occupancy cars was taken as proxy for the total potential of peer-providers (i.e., drivers), and peer-users (i.e., passengers). In this way, it is not possible to distinguish between whether current single-occupancy commuters would be a driver or a passenger, however this is more realistic representation of ride sharing behaviours among commuters. In addition to these potential adopters who take a flexible role, the number of commuters in the UK travelling by public transport was also estimated. This group of the population represents those potential adopters who do not currently drive themselves to work, and therefore would take on the role of a peer-user (i.e., passenger) only.

It was decided to take the number of appropriate vehicles which could be used in P2P car sharing schemes as the basis to estimate the potential number of P2P car sharing providers. There are strict requirements and criteria which a vehicle must fulfil to be listed on a P2P car

sharing platform. Across the main P2P car sharing platforms in the UK, the most common of these criteria were found to be that the car must be privately owned (excluding company cars and lease cars), had to be less than 10 years old, and had to be under insurance group 40. There are no population-level data sets of how many cars fall into each insurance group in the UK. Insurance groups range from 1 – 50, with cars in the highest insurance groups typically being larger and more powerful, higher-end brands, and classic cars. To overcome this missing datapoint, the number of cars in the UK under 3001cc was used as a proxy for being under insurance group 40.

Appendix 2: additional statistical reporting

2.1. Additional statistical reporting

2.1.1. Technophilia

Rotated Component Matrix for PCA with Varimax with Kaiser Normalisation Rotation of a two-component output		
	Component	
Items	1	2
technophilia scale - I want to be among the first people to try a new technology	-.872	.072
technophilia scale - I invest in new technologies soon after they become available for purchase	-.835	-.014
technophilia scale - I often take my time before making a decision to invest in a new technology	.222	.665
technophilia scale - I am often sceptical about new technologies	.458	.643
technophilia scale - I tend to invest in new technology once I have been convinced about the benefits of using it	-.296	.741
technophilia scale - I rarely invest in new technologies	.696	.291
technophilia scale - I prefer to stick to existing technologies I am familiar with	.629	.442
Rotation converged in 3 iterations.		

2.1.2. Sociableness

Component Matrix for PCA of a one-component output	
	Component
Items	1
sociability scale - It is pleasant to meet new people	.752
sociability scale - I regularly participate in social activity	.806
sociability scale - I see myself as someone who is outgoing	.876
sociability scale - I see myself as someone who is reserved	-.743
1 components extracted.	

2.1.3. Trust

2.1.3.1. *P2P ride sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
trust scale - The other users of Liftshare are truthful in dealing with one another	.854
trust scale - The other users of Liftshare will not take advantage of me	.865
trust scale - Liftshare provides a robust and safe environment in which I can use the service	.879
trust scale - Overall, Liftshare is trustworthy	.929
trust scale - The other users of Liftshare are trustworthy	.910
1 components extracted.	

2.1.3.2. *P2P car sharing*

Component Matrix for PCA of a one-component output	
Items	Component 1
trust scale - The other users of peer-to-peer car sharing are truthful in dealing with one another	.855
trust scale - The other users of peer-to-peer car sharing will not take advantage of me	.867
trust scale - Peer-to-peer car sharing platforms provide a robust and safe environment in which I can use the service	.849
trust scale - Overall, peer-to-peer car sharing is trustworthy	.878
trust scale - The other users of peer-to-peer car sharing are trustworthy	.874
1 components extracted.	

2.1.4. Opinion Leadership

2.1.4.1. *P2P ride sharing*

Rotated Component Matrix for PCA with Varimax with Kaiser Normalisation Rotation of a two-component output		
Items	Component 1	2
opinion leadership - I often influence people's opinions about Liftshare	.928	-.057
opinion leadership - I often persuade other people to use Liftshare that I like	.939	-.053
opinion leadership - People I know pick Liftshare based on what I have told them	.904	-.046
opinion leadership - Other people rarely come to me for advice about choosing Liftshare	-.187	.795
opinion leadership - My opinion on Liftshare seems not to count with other people	.084	.840
Rotation converged in 3 iterations.		

2.1.4.2. *P2P car sharing*

Rotated Component Matrix for PCA with Varimax with Kaiser Normalisation Rotation of a two-component output		
	Component	
Items	1	2
opinion leadership - I often influence people's opinions about P2P car sharing	.861	-.202
opinion leadership - I often persuade other people to use P2P car sharing that I like	.960	-.042
opinion leadership - People I know pick P2P car sharing based on what I have told them	.948	-.034
opinion leadership - Other people rarely come to me for advice about choosing P2P car sharing	-.262	.817
opinion leadership - My opinion on P2P car sharing seems not to count with other people	.064	.890
Rotation converged in 3 iterations.		

2.1.5. Complexity

2.1.5.1. *P2P ride sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
complexity and compatibility scale - Using Liftshare would often be frustrating	.888
complexity and compatibility scale - Using Liftshare would take a lot of effort	.888
1 component extracted.	

2.1.5.2. *P2P car sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
complexity and compatibility scale - Using peer-to-peer car sharing would often be frustrating	.928
complexity and compatibility scale - Using peer-to-peer car sharing would take a lot of effort	.928
1 component extracted.	

2.1.6. Compatibility

2.1.6.1. *P2P ride sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
complexity and compatibility scale - Using Liftshare is compatible with my daily life	.829
complexity and compatibility scale - Using Liftshare fits well with the way I like to live	.848
complexity and compatibility scale - Using Liftshare is compatible with my values and beliefs	.611
complexity and compatibility scale - I find it easy to use Liftshare	.796
complexity and compatibility scale - Learning to use Liftshare was easy for me	.681
1 components extracted.	

2.1.6.2. *P2P car sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
complexity and compatibility scale - Using peer-to-peer car sharing would be compatible with my daily life	.869
complexity and compatibility scale - Using peer-to-peer car sharing would fit well with the way I like to live	.855
complexity and compatibility scale - Using peer-to-peer car sharing would be compatible with my values and beliefs	.616
complexity and compatibility scale - I would find it easy to use peer-to-peer car sharing	.845
complexity and compatibility scale - Learning to use peer-to-peer car sharing would be easy for me	.708
1 components extracted.	

2.1.7. Trialability

2.1.7.1. *P2P ride sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
trialability scale - It's possible to use Liftshare on a trial basis long enough to see what it can do	.833
trialability scale - People have confidence in using Liftshare.	.833
1 components extracted.	

2.1.7.2. *P2P car sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
trialability scale - It's possible to use peer-to-peer car sharing on a trial basis long enough to see what it can do	.833
trialability scale - People have confidence in using peer-to-peer car sharing.	.833
1 components extracted.	

2.1.8. Observability

2.1.8.1. *P2P ride sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
observability scale - The results of using Liftshare are apparent to me	.835
observability scale - It is easy to know if someone uses Liftshare	.441
observability scale - I would have no difficulty telling others about the results of using Liftshare	.768
1 components extracted.	

2.1.8.2. *P2P car sharing*

Component Matrix for PCA of a one-component output	
	Component
Items	1
observability scale - The results of using peer-to-peer car sharing are apparent to me	.845
observability scale - It is easy to know if someone uses peer-to-peer car sharing	.489
observability scale - I would have no difficulty telling others about the results of using peer-to-peer car sharing	.738
1 components extracted.	

2.1.9. Relative advantage

2.1.9.1. *P2P ride sharing*

Rotated Component Matrix for PCA with Varimax with Kaiser Normalisation Rotation of a three-component output			
	Component		
Items	1	2	3
rep grid attributes - Using Liftshare makes a good impression on others	.527	.057	-.040
rep grid attributes - Using Liftshare is too expensive	-.257	-.154	.730
rep grid attributes - Using Liftshare is a status symbol	.088	.093	.803
rep grid attributes - Using Liftshare is convenient	.151	.769	-.216
rep grid attributes - Using Liftshare helps save money	.576	.245	-.441
rep grid attributes - Using Liftshare helps address climate change	.848	-.016	-.158
rep grid attributes - Using Liftshare helps the local community	.837	.094	.022
rep grid attributes - Using Liftshare helps people feel more connected	.663	.326	-.009
rep grid attributes - Using Liftshare helps protect the environment	.868	.071	-.113
rep grid attributes - Using Liftshare increases autonomy	.070	.832	.116
Rotation converged in 4 iterations.			

2.1.9.2. *P2P car sharing*

Rotated Component Matrix for PCA with Varimax with Kaiser Normalisation Rotation of a three-component output			
	Component		
Items	1	2	3
rep grid attributes - Using peer-to-peer car sharing makes a good impression on others	.691	.246	-.035
rep grid attributes - Using peer-to-peer car sharing is too expensive	.009	-.136	-.753
rep grid attributes - Using peer-to-peer car sharing is a status symbol	.031	.730	-.071
rep grid attributes - Using peer-to-peer car sharing is convenient	.302	-.319	.707
rep grid attributes - Using peer-to-peer car sharing helps save money	.236	.302	.744
rep grid attributes - Using peer-to-peer car sharing helps address climate change	.440	.736	.250
rep grid attributes - Using peer-to-peer car sharing helps the local community	.743	.265	.158
rep grid attributes - Using peer-to-peer car sharing helps people feel more connected	.700	.319	.176
rep grid attributes - Using peer-to-peer car sharing helps protect the environment	.447	.692	.283

rep grid attributes - Using peer-to-peer car sharing increases autonomy	.721	-.195	.287
Rotation converged in 5 iterations.			

Appendix 3: full table of results from chapter 6

Table 28: Per-person emissions impacts from using P2P mobility innovations.

		Adopter group											
		Commuter			One-off			P2P car sharing users			P2P car sharing providers		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Effect	**Unit**												
Emissions from P2P mobility	$kgCO_2/p/yr$	552	318	114	132.88	44.29	7.38	540.38	164.77	40.21			
Emissions from counterfactual - single occupancy	$kgCO_2/p/yr$	1656	1656	1656	358.79	358.79	358.79						
Emissions from counterfactual - public transport	$kgCO_2/p/yr$	385	385	385	102	102	102	76.57	76.57	76.57			
Substitution effect - single occupancy	$\Delta\ kgCO_2/p/yr$	1104	509	114	226	75	13	0	0	0			
Substitution effect - single occupancy	%Δ	67%	31%	7%	63%	21%	3%	0	0	0			
Substitution effect - public transport	$\Delta\ kgCO_2/p/yr$	-167	-126	-61	-31	-10	-2						
Substitution effect - public transport	%Δ	-43%	-33%	-16%	-31%	-10%	-2%	-606%	-165%	-36%			
Substitution effect - B2C car rental	$\Delta\ kgCO_2/p/yr$							0	0	0			
Suppression effect (use and embodied)	$\Delta\ tCO_2/p/yr$	0.82	0.41	0.26	0.82	0.42	0.27	0.63	0.32	0.21	0.4	0.61	1.24
Shedding effect (use and embodied)	$\Delta\ tCO_2/p/yr$	0.20	0.10	0.07	0.05	0.03	0.02	0.11	0.06	0.04	0.28	0.46	0.89

Table 29: The full technical potential emissions impacts from using P2P mobility innovations (assuming full adoption of P2P mobility).

		Adopter group											
		Commuter			**One-off**			**P2P car sharing users**			**P2P car sharing providers**		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Effect	**Unit**												
Substitution effect – weighted average reference point	Δ tCO_2/yr	21230965	9693802	2094052	6625666	2208555	368093	-1552161	-423267	-91869			
Suppression effect (use and embodied)	Δ tCO_2/yr	15981224	8106424	5155608	24791686	12664989	8120918	7152293.622	635180.852	2323852.394	-2196831.134	-1124755.319	-723030.9933
Shedding effect (use and embodied)	Δ tCO_2/yr	3995306	2026606	1288902	6197921	3166247	2030229	2654368.107	332288.485	843474.816	-1464554.089	-749836.8795	-482020.6622

Table 30: The behaviourally realistic emissions impacts from using P2P mobility innovations.

		Adopter group											
		Commuter			One-off			P2P car sharing users			P2P car sharing providers		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Effect	**Unit**												
Substitution effect – weighted average reference point	Δ tCO_2/yr	3103553	1389801	281778	576833	192278	32046	-382732	-104369	-22653			
Suppression effect (use and embodied)	Δ tCO_2/yr	2405101	1219980	775895	2195161	1121412	719060	1736081	888856	571387	-23832	-23322	-20576
Shedding effect (use and embodied)	Δ tCO_2/yr	601275	304995	193974	548790	290905	200870	626980	321008	206355	-116798	-68126	-46227

Table 31: The emissions impacts for each adopter group from the four future scenarios.

		Adopter group											
		Commuter			**One-off**			**P2P car sharing users**			**P2P car sharing providers**		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
scenario 1: substitution effect	Δ $mtCO_2/yr$	0.2369	0.1184	0.0325	0.0002	0.0001	0.0000	-0.0182	-0.0012	0.0101			
scenario 1: suppression effect	Δ $mtCO_2/yr$	0.1010	0.0519	0.0365	0.1714	0.0887	0.0579	0.2529	0.1295	0.0836	-0.0832	-0.0426	-0.0274
scenario 1: shedding effect	Δ $mtCO_2/yr$	0.0302	0.0157	0.0132	0.0652	0.0344	0.0230	0.0401	0.0206	0.0136	-0.0416	-0.0213	-0.0137
scenario 2: substitution effect	Δ $mtCO_2/yr$	0.8018	0.4009	0.1102	0.1539	0.0513	0.0085	-0.4182	-0.2979	-0.1775			
scenario 2: suppression effect	Δ $mtCO_2/yr$	0.8079	0.4143	0.2770	0.3427	0.1775	0.1158	1.7014	0.8629	0.5541	-0.6653	-0.3406	-0.2190
scenario 2: shedding effect	Δ $mtCO_2/yr$	0.2885	0.1484	0.1060	0.1415	0.0725	0.0466	0.4760	0.2355	0.1507	-0.3327	-0.1703	-0.1095
scenario 3: substitution effect	Δ $mtCO_2/yr$	0.4343	0.2171	0.0597	0.8834	0.2945	0.0491	-0.0291	-0.0019	0.0162			

scenario 3: suppression effect	Δ $mtCO_2/yr$	0.1851	0.0952	0.0669	0.7430	0.3918	0.2619	0.6905	0.3536	0.2279	-0.2661	-0.1363	-0.0876
scenario 3: shedding effect	Δ $mtCO_2/yr$	0.0553	0.0287	0.0242	0.2591	0.1440	0.1027	0.2003	0.1026	0.0666	-0.1331	-0.0681	-0.0438
scenario 4: substitution effect	Δ $mtCO_2/yr$	6.7382	3.3691	0.9259	1.6653	0.5551	0.0925	-0.6692	-0.4766	-0.2840			
scenario 4: suppression effect	Δ $mtCO_2/yr$	12.1054	6.2037	4.0771	16.0114	8.2191	5.3025	3.7572	1.9104	1.2271	-1.5967	-0.8175	-0.5255
scenario 4: shedding effect	Δ $mtCO_2/yr$	2.0333	1.0468	0.7621	3.1064	1.6119	1.0552	1.5785	0.7950	0.5101	-0.7984	-0.4088	-0.2628

Appendix 4: online survey questionnaire

4.1. Non adopter survey

Start of Block: Travel behaviour

First, we would like to understand a little about your travel behaviours.

First, we would like to understand a little about your travel behaviours.

Do you commute between home and work?
Yes / No

Skip To: End of Block If Do you commute between home and work? = No

Which mode of transport do you most often use for your daily commute?
Car driver (own car) /Car driver (ride share/ carpool with others) / Car driver (car club) /Car passenger /Car passenger (ride share/ carpool with others) /Motorbike/ moped / Taxi / minicab / Bicycle / Metro/ tram/ light rail / Train / Intra-urban bus / Inter-urban bus (coach) / Walking

Display This Question:

If Which mode of transport do you most often use for your daily commute? = Car driver (ride share/ carpool with others)

Or Which mode of transport do you most often use for your daily commute? = Car passenger (ride share/ carpool with others)

*

You said that you commute with others, how many other people do you typically share your commute with? (excluding yourself)

What is the approximate distance, in miles, of your daily commute (i.e. your one-way journey from home to work)?

How long does your commute generally take (each way)?

Start of Block: Car ownership

Do you currently have a drivers license?
Yes / No / Don't know

How many cars does your household currently have? (please include lease cars or company cars where appropriate)
0 / 1 / 2 / 3 / 4 / More than 4

Skip To: End of Block If How many cars does your household currently have? (please include lease cars or company cars wher... = 0

What is the make, model and year of your primary car?

Is your primary car ...
Petrol / Diesel / Hybrid / Electric / Don't know

Approximately how many miles do you drive in an average month in your car?

End of Block: Car ownership

Start of Block: P2P car share filter

Next we are going to ask you some questions about two peer-to-peer mobility innovations.

Peer-to-peer CAR sharing is when a car owner provides temporary access to their car to another user in exchange for payment. It is different from traditional car rental because you rent someone's personal car. It's a bit like AirBnB, but for cars. Examples include Hiyacar, Turo and Drivy.

Have you ever used a peer-to-peer car sharing platform?
Yes, currently/ In the past, but not now / No, but I have heard of this / No, and I have never heard of this

End of Block: P2P car share filter

Start of Block: P2P ride share filter

Peer-to-peer RIDE sharing is where you travel in a car with someone else who is travelling along your route. You can be connected with other people going to the same destination as you through an online platform or an app. Examples include Blablacar and Liftshare.

Have you ever used a peer-to-peer ride sharing platform?
Yes, currently/ In the past, but not now / No, but I have heard of this / No, and I have never heard of this

End of Block: P2P ride share filter

Start of Block: P2P car share attributes for familiars

You said that you have used, or are familiar with, peer-to-peer CAR SHARING before, is that correct?
Yes / No

Display This Question:

If You said that you have used, or are familiar with, peer-to-peer CAR SHARING before, is that corre... = No

Thank you, this branch is specifically for people who have some familiarity with peer-to-peer car sharing. We will now direct you back to the main survey.

Skip To: End of Block If Thank you, this branch is specifically for people who have some familiarity with peer-to-peer car...() Is Displayed

The following questions are about peer-to-peer CAR sharing.

Display This Question:

If Have you ever used a peer-to-peer car sharing platform? = Yes, currently

Or Have you ever used a peer-to-peer car sharing platform? = In the past, but not now

What is the name of the peer-to-peer car share platform you have used? _____

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
The other users of peer-to-peer car sharing are truthful in dealing with one another (1)	○	○	○	○	○
The other users of peer-to-peer car sharing will not take advantage of me (2)	○	○	○	○	○
Peer-to-peer car sharing platforms provide a robust and safe environment in which I can use the service (3)	○	○	○	○	○
Overall, peer-to-peer car sharing is trustworthy (4)	○	○	○	○	○
The other users of peer-to-peer car sharing are trustworthy (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using peer-to-peer car sharing makes a good impression on others (1)	○	○	○	○	○
Using peer-to-peer car sharing is too expensive (2)	○	○	○	○	○
Using peer-to-peer car sharing is a status symbol (3)	○	○	○	○	○
Using peer-to-peer car sharing is convenient (4)	○	○	○	○	○
Using peer-to-peer car sharing helps save money (5)	○	○	○	○	○
Using peer-to-peer car sharing helps address climate change (6)	○	○	○	○	○
Using peer-to-peer car sharing helps the local community (7)	○	○	○	○	○
Using peer-to-peer car sharing helps people feel more connected (8)	○	○	○	○	○
Using peer-to-peer car sharing helps protect the environment (9)	○	○	○	○	○
Using peer-to-peer car sharing increases autonomy (10)	○	○	○	○	○

Page Break

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using peer-to-peer car sharing would be compatible with my daily life (1)	○	○	○	○	○
Using peer-to-peer car sharing would fit well with the way I like to live (2)	○	○	○	○	○
Using peer-to-peer car sharing would be compatible with my values and beliefs (3)	○	○	○	○	○
Using peer-to-peer car sharing would take a lot of effort (4)	○	○	○	○	○
Using peer-to-peer car sharing would often be frustrating (5)	○	○	○	○	○
I would find it easy to use peer-to-peer car sharing (6)	○	○	○	○	○
Learning to use peer-to-peer car sharing would be easy for me (7)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I would have no difficulty telling others about the results of using peer-to-peer car sharing (1)	○	○	○	○	○
I would have difficulty explaining what the consequences are of using peer-to-peer car sharing (2)	○	○	○	○	○
The results of using peer-to-peer car sharing are apparent to me (3)	○	○	○	○	○
It is easy to know if someone uses peer-to-peer car sharing (4)	○	○	○	○	○
It's not easy to see who's using peer-to-peer car sharing (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
It's possible to use peer-to-peer car sharing on a trial basis long enough to see what it can do (1)	○	○	○	○	○
People have confidence in using peer-to-peer car sharing (2)	○	○	○	○	○

Page Break

How important have these sources of information been in shaping your opinion of peer-to-peer car sharing?

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	Not at all important (5)
Specialist media e.g., transport-related magazines, websites (1)	○	○	○	○	○
General news media e.g., TV, radio, newspapers, websites (2)	○	○	○	○	○
Organisations, service providers, companies, local bodies (3)	○	○	○	○	○
Conversations with friends, family, colleagues (4)	○	○	○	○	○
Social media (5)	○	○	○	○	○
Seeing what others are doing (6)	○	○	○	○	○
Other [please specify] (7)	○	○	○	○	○

To what extent do you agree with the following statements about peer-to-peer car sharing?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I often influence people's opinions about peer-to-peer car sharing (1)	○	○	○	○	○
I often persuade other people to use peer-to-peer car sharing that I like (3)	○	○	○	○	○
People I know pick peer-to-peer car sharing based on what I have told them (4)	○	○	○	○	○
Other people rarely come to me for advice about choosing peer-to-peer car sharing (5)	○	○	○	○	○
My opinion on peer-to-peer car sharing seems not to count with other people (6)	○	○	○	○	○

Display This Question:

If Have you ever used a peer-to-peer car sharing platform? = Yes, currently

Or Have you ever used a peer-to-peer car sharing platform? = In the past, but not now

Roughly how many people would you say you have spoken with (in person or via phone/internet) about peer-to-peer car sharing since you started using it?_____

Display This Question:

If Have you ever used a peer-to-peer car sharing platform? = No, but I have heard of this

Roughly how many people would you say you have spoken with (in person or via phone/internet) about peer-to-peer car sharing?

_____

End of Block: P2P car share attributes for familiars

Start of Block: P2P ride share attributes for familiars

You said that you have used, or are familiar with, peer-to-peer RIDE SHARING before, is that correct?
Yes / No

Display This Question:

If You said that you have used, or are familiar with, peer-to-peer RIDE SHARING before, is that corr... = No

Thank you, this branch is specifically for people who have some familiarity with peer-to-peer ride sharing. We will now direct you back to the main survey.

Skip To: End of Survey If Thank you, this branch is specifically for people who have some familiarity with peer-to-peer rid...() Is Displayed

The following questions are about peer-to-peer RIDE sharing

Display This Question:

If Have you ever used a peer-to-peer ride sharing platform? = Yes, currently

Or Have you ever used a peer-to-peer ride sharing platform? = In the past, but not now

What is the name of the peer-to-peer ride share platform you have used?

_____

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
The other users of peer-to-peer ride sharing are truthful in dealing with one another (1)	○	○	○	○	○
The other users of peer-to-peer ride sharing will not take advantage of me (2)	○	○	○	○	○
Peer-to-peer ride sharing platforms provide a robust and safe environment in which I can use the service (3)	○	○	○	○	○
Overall, peer-to-peer ride sharing is trustworthy (4)	○	○	○	○	○
The other users of peer-to-peer ride sharing are trustworthy (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using peer-to-peer ride sharing makes a good impression on others (1)	○	○	○	○	○
Using peer-to-peer ride sharing is too expensive (2)	○	○	○	○	○
Using peer-to-peer ride sharing is a status symbol (3)	○	○	○	○	○
Using peer-to-peer ride sharing is convenient (4)	○	○	○	○	○
Using peer-to-peer ride sharing helps save money (5)	○	○	○	○	○
Using peer-to-peer ride sharing helps address climate change (6)	○	○	○	○	○
Using peer-to-peer ride sharing helps the local community (7)	○	○	○	○	○
Using peer-to-peer ride sharing helps people feel more connected (8)	○	○	○	○	○
Using peer-to-peer ride sharing helps protect the environment (9)	○	○	○	○	○
Using peer-to-peer ride sharing increases autonomy (10)	○	○	○	○	○

Page Break

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using peer-to-peer ride sharing would be compatible with my daily life (1)	○	○	○	○	○
Using peer-to-peer ride sharing would fit well with the way I like to live (2)	○	○	○	○	○
Using peer-to-peer ride sharing would be compatible with my values and beliefs (3)	○	○	○	○	○
Using peer-to-peer ride sharing would take a lot of effort (4)	○	○	○	○	○
Using peer-to-peer ride sharing would be often frustrating (5)	○	○	○	○	○
I would find it easy to use peer-to-peer ride sharing (6)	○	○	○	○	○
Learning to use peer-to-peer ride sharing would be easy for me (7)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I would have no difficulty telling others about the results of using peer-to-peer ride sharing (1)	○	○	○	○	○
I would have difficulty explaining what the consequences are of using peer-to-peer ride sharing (2)	○	○	○	○	○
The results of using peer-to-peer ride sharing are apparent to me (3)	○	○	○	○	○
It is easy to know if someone uses peer-to-peer ride sharing (4)	○	○	○	○	○
It's not easy to see who's using peer-to-peer ride sharing (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
It's possible to use peer-to-peer ride sharing on a trial basis long enough to see what it can do (1)	○	○	○	○	○
People have confidence in using peer-to-peer ride sharing (2)	○	○	○	○	○

Page Break

How important have these sources of information been in shaping your opinion of peer-to-peer ride sharing?

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	Not at all important (5)
Specialist media e.g., transport-related magazines, websites (1)	○	○	○	○	○
General news media e.g., TV, radio, newspapers, websites (2)	○	○	○	○	○
Organisations, service providers, companies, local bodies (3)	○	○	○	○	○
Conversations with friends, family, colleagues (4)	○	○	○	○	○
Social media (5)	○	○	○	○	○
Seeing what others are doing (6)	○	○	○	○	○
Other [please specify] (7)	○	○	○	○	○

To what extent do you agree with the following statements about peer-to-peer ride sharing?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I often influence people's opinions about peer-to-peer ride sharing (1)	○	○	○	○	○
I often persuade other people to use peer-to-peer ride sharing that I like (3)	○	○	○	○	○
People I know pick peer-to-peer ride sharing based on what I have told them (4)	○	○	○	○	○
Other people rarely come to me for advice about choosing peer-to-peer ride sharing (5)	○	○	○	○	○
My opinion on peer-to-peer ride sharing seems not to count with other people (6)	○	○	○	○	○

Display This Question:

If Have you ever used a peer-to-peer ride sharing platform? = Yes, currently

Or Have you ever used a peer-to-peer ride sharing platform? = In the past, but not now

Roughly how many people would you say you have spoken with (in person or via phone/internet) about peer-to-peer ride sharing since you started using it?

_____

Display This Question:

If Have you ever used a peer-to-peer ride sharing platform? = No, but I have heard of this

Roughly how many people would you say you have spoken with (in person or via phone/internet) about peer-to-peer ride sharing?

_____

End of Block: P2P ride share attributes for familiars

Start of Block: Personality

The next questions will help us understand a little about you.

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
It is pleasant to meet new people (1)	○	○	○	○	○
I regularly participate in social activity (2)	○	○	○	○	○
I see myself as someone who is outgoing (3)	○	○	○	○	○
I see myself as someone who is reserved (4)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I want to be among the first people to try a new technology (1)	○	○	○	○	○
I invest in new technologies soon after they become available for purchase (2)	○	○	○	○	○
I often take my time before making a decision to invest in a new technology (3)	○	○	○	○	○
I am often skeptical about new technologies (4)	○	○	○	○	○
I tend to invest in new technology once I have been convinced about the benefits of using it (5)	○	○	○	○	○
I rarely invest in new technologies (6)	○	○	○	○	○
I prefer to stick to existing technologies I am familiar with (7)	○	○	○	○	○

How important are these values as guiding principles in your life?

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	Not at all important (5)
Authority, the right to lead or command (1)	○	○	○	○	○
Influential, having impact on people and events (2)	○	○	○	○	○
Wealth, material possessions, money (3)	○	○	○	○	○
Social justice: correcting injustice, care for the weak (4)	○	○	○	○	○
A world at peace: free of war and conflict (5)	○	○	○	○	○
Protecting the environment: preserving nature (6)	○	○	○	○	○
Honouring parents and elders, showing respect (7)	○	○	○	○	○
Family security, safety for loved ones (8)	○	○	○	○	○
Self-discipline, self-restraint, resistance to temptation (9)	○	○	○	○	○
A varied life, filled with challenge, novelty and change (10)	○	○	○	○	○
An exciting life, stimulating experiences (11)	○	○	○	○	○
Curious, interested in everything, exploring (12)	○	○	○	○	○

End of Block: Personality

Start of Block: Socioeconomic

Finally, we have a few questions to help us understand your current situation a little.

What is your postcode sector? (The letters, and first 2 numbers that comprise your postcode, for example NR10 1xx)

How do you identify your gender?
Male / Female / Non - binary / Prefer not to say

How old are you?

Under 18 / 18 - 24 / 25 - 34 / 35 - 44 / 45 - 54 / 55 - 64 / 65 - 74 / 75 or older

What is your annual household income before taxes?
Under £9,500 / £9,500 - £15,499 / £15,500 - £24,999 / £25,000 - £49,999 / £50,000 - £74,999 / £75,000 or over / Don't know / Rather not say

Which best describes your current financial situation?
Healthy - I have money left at the end of the month for a few luxuries or to add to my savings / OK - I get by, but there's not a lot left by the time the basics are taken care of / Tight - I'm making ends meet, but only just / Struggling - I'm in danger of falling behind with bills or loan repayments / In trouble - I've missed loan repayments or household bills

Which of these best describes your current employment situation?
In paid employment (full or part-time) / Unemployed / Retired / On maternity leave / Looking after family or home / Full-time student / Long-term sick or disabled / On a government training scheme / Unpaid worker in family business / Working in an apprenticeship / Doing something else

Which is the highest educational or school qualification you have obtained?
PhD or equivalent doctoral level qualification / Masters or equivalent higher degree level qualification / Bachelors or equivalent first degree qualification / Post-secondary academic below-degree level qualification (up to 1 year) / Post-secondary academic below-degree level qualification (2 and more years) / Post-secondary vocational training (up to 1 year) / Post-secondary vocational training (2 and more years) / Completed secondary school / Completed primary school / None of the above

How many people are in your household?
1 / 2 / 3 / 4 / 5 / more than 5

Of these people, how many ...

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	More than 5 (7)
... Are pre-school children? (1)	○	○	○	○	○	○	○
... Are children who go to school? (2)	○	○	○	○	○	○	○
... Are over the age of 65? (3)	○	○	○	○	○	○	○
... Regularly spend time at home on week days? (4)	○	○	○	○	○	○	○

Do you personally have a smart phone?
Yes / No / Do not know

How often do you use the internet for your personal use?

Every day / Several times a week / Several times a month / Once a month / Less than once a month / Never use / No access at home, at work or elsewhere

Do you use any of the following social media? (Select all that apply)
None / Facebook / Twitter / Instagram / Linkedin / I don't know

End of Block: Socio economic

Start of Block: Follow up

Thank you! That's all our questions. We very much appreciate your help with our research project.

If you're interested, you can find further details about the project here: silci.org

We may want to contact you again to see if you would like to take part in follow-up research. May we contact you again solely for the purposes of this research project?

No / Yes, you can contact me by email on [enter email]

4.2. P2P car sharing adopter survey

Start of Block: Travel behaviour

First, we would like to understand a little about your travel behaviours.

Do you commute between home and work?

Yes / No

Skip To: End of Block If Do you commute between home and work? = No

Which mode of transport do you most often use for your daily commute?

Car driver (own car) /Car driver (ride share/ carpool with others) / Car driver (car club) /Car passenger /Car passenger (ride share/ carpool with others) /Motorbike/ moped / Taxi / minicab / Bicycle / Metro/ tram/ light rail / Train / Intra-urban bus / Inter-urban bus (coach) / Walking

Display This Question:
If Which mode of transport do you most often use for your daily commute? = Car driver (ride share/ carpool with others)
Or Which mode of transport do you most often use for your daily commute? = Car passenger (ride share/ carpool with others)

You said that you commute with others, how many other people do you typically share your commute with? (excluding yourself)

What is the approximate distance, in miles, of your daily commute (i.e. your one-way journey from home to work)?

How long does your commute generally take (each way)?

Start of Block: Car ownership

Do you currently have a drivers license?

Yes / No / Don't know

How many cars does your household currently have? (please include lease cars or company cars where appropriate)

0 / 1 / 2 / 3 / 4 / More than 4

Skip To: End of Block If How many cars does your household currently have? (please include lease cars or company cars where... = 0

What is the make, model and year of your primary car?

Is your primary car ...

Petrol / Diesel / Hybrid / Electric / Don't know

Approximately how many miles do you drive in an average month in your car?

_____

How important were each of these when deciding to buy your car?

	Extremely important (13)	Very important (14)	Moderately important (15)	Slightly important (16)	Not at all important (17)
Purchase cost (1)	○	○	○	○	○
Running cost (2)	○	○	○	○	○
Fuel efficiency (3)	○	○	○	○	○
Style / design (4)	○	○	○	○	○
Comfort (5)	○	○	○	○	○
Brand reputation (6)	○	○	○	○	○
Space / functionality (7)	○	○	○	○	○
Reliability (8)	○	○	○	○	○
Safety (9)	○	○	○	○	○
Speed / performance (10)	○	○	○	○	○
Other (please specify) (11)	○	○	○	○	○

End of Block: Car ownership

Start of Block: Use of [P2P car share platform]

Next, we are going to ask you some questions about peer-to-peer car sharing.

Peer-to-peer car sharing is when a car owner provides temporary access to their car to another user, in exchange for payment. It is different from traditional car rental because you rent someone's personal car. It's a bit like AirBnB, but for cars. Examples include Hiyacar, Turo and Drivy.

Have you ever used a peer-to-peer car sharing platform?

Yes, currently / In the past, but not now / No, but I have heard of this / No, and I have never heard of this

Skip To: End of Block If Have you ever used a peer-to-peer car sharing platform? = No, and I have never heard of this
Skip To: End of Block If Have you ever used a peer-to-peer car sharing platform? = No, but I have heard of this

Which peer-to-peer car sharing platform have you used most recently?

Hiyacar / Drivy / Turo / Car and Away / EasyCar Club / Rentecarlo / Ridelink / Other (please specify)

Display This Question:
If How many cars does your household currently have? (please include lease cars or company cars wher... != 0

Have you ever used ${Q105/ChoiceGroup/SelectedChoices} to rent out your car **to** someone else?

Yes / No / Don't know

Have you ever used ${Q105/ChoiceGroup/SelectedChoices} to rent a car **from** someone else?

Yes / No / Don't know

Display This Question:
If Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent out your car to someone else... = Yes
And Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent a car from someone else? = Yes

Which do you do more, rent out your car, or rent a car from someone, via ${Q105/ChoiceGroup/SelectedChoices}?

Mostly rent out my own car / Rent out my car, and rent a car from someone equally / Mostly rent a car from someone

Display This Question:
If Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent out your car to someone else... = Yes

How often do you rent out your car **to** someone else through ${Q105/ChoiceGroup/SelectedChoices}?
Every day / Several times a week / Several times a month / Once a month / Less than once a month (please specify)

Display This Question:
If Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent out your car to someone else... = Yes

Please rate how important each of the following were relative in your decision to rent out your car through ${Q105/ChoiceGroup/SelectedChoices}?

	Extremely important (13)	Very important (14)	Moderately important (15)	Slightly important (16)	Not at all important (17)
Expected financial benefit (1)	○	○	○	○	○
Meeting people (2)	○	○	○	○	○
Contributing to a healthy natural environment (3)	○	○	○	○	○

Display This Question:
If Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent a car from someone else? = Yes

How often do you rent a car **from** someone else through ${Q105/ChoiceGroup/SelectedChoices}?

Every day / Several times a week / Several times a month / Once a month / Less than once a month (please specify)

Display This Question:
If Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent a car from someone else? = Yes

Thinking about the last journey you made using a car from ${Q105/ChoiceGroup/SelectedChoices}, if a car had not been available through ${Q105/ChoiceGroup/SelectedChoices}, how would you have made this journey?

Would not have made the journey/ Rent a car from a traditional car rental scheme / Borrow a car from friends or family / Rent a car from another P2P car share scheme / Drive my own car / Use public transport [please specify which mode] / Taxi / minicab (9)

Display This Question:
If Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent a car from someone else? = Yes

Thinking about the last journey you made using a car from ${Q105/ChoiceGroup/SelectedChoices}, roughly how many miles did you travel in this car?

Display This Question:
If Have you ever used ${q://QID105/ChoiceGroup/SelectedChoices} to rent a car from someone else? = Yes

Thinking about the last journey you made using a car from ${Q105/ChoiceGroup/SelectedChoices}, roughly how long did you rent this car for?

Less than a half day / A half day / Between a half day and a day / 1 day / 1 - 2 days / 2 - 3 days / Longer than 3 days [please specify]

Apart from ${Q105/ChoiceGroup/SelectedChoices}, have you ever used another peer-to-peer ride sharing platform? If so, which one?
Yes / No / _____

Display This Question:
If Have you ever used a peer-to-peer car sharing platform? = In the past, but not now
Or Have you ever used a peer-to-peer car sharing platform? = Yes, currently

How many cars did your household have before joining ${Q105/ChoiceGroup/SelectedChoices}?
0 / 1 / 2 / 3 / 4 / More than 4

Display This Question:
If How many cars does your household currently have? (please include lease cars or company cars wher... != 0
And Have you ever used a peer-to-peer car sharing platform? = Yes, currently
Or Have you ever used a peer-to-peer car sharing platform? = In the past, but not now

How has your monthly car driver mileage changed because of joining ${Q105/ChoiceGroup/SelectedChoices}?
Decreased a lot / Decreased a little / Stayed the same (no change) / Increased a little / Increased a lot

Display This Question:
If Have you ever used a peer-to-peer car sharing platform? = Yes, currently
Or Have you ever used a peer-to-peer car sharing platform? = In the past, but not now

Do you think that joining ${Q105/ChoiceGroup/SelectedChoices} has made it more or less likely that your household will buy an additional car in the next year?
More likely / Less likely / No effect / Don't know

Display This Question:
If How many cars does your household currently have? (please include lease cars or company cars wher... != 0

What would encourage you to sell or dispose of your car?
_____

End of Block: Use of [P2P car share platform]

Start of Block: Attributes of [P2P car share platform]

Now, we are going to ask you what you think about certain attributes of ${Q105/ChoiceGroup/SelectedChoices}

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
The other users of ${Q105/ChoiceGroup/SelectedChoices} are truthful in dealing with one another (1)	○	○	○	○	○
The other users of ${Q105/ChoiceGroup/SelectedChoices} will not take advantage of me (2)	○	○	○	○	○
${Q105/ChoiceGroup/SelectedChoices} provides a robust and safe environment in which I can use the service (3)	○	○	○	○	○
Overall, ${Q105/ChoiceGroup/SelectedChoices} is trustworthy (4)	○	○	○	○	○
The other users of ${Q105/ChoiceGroup/SelectedChoices} are trustworthy (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using ${Q105/ChoiceGroup/SelectedChoices} makes a good impression on others (1)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} is too expensive (2)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} is a status symbol (3)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} is convenient (4)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} helps save money (5)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} helps address climate change (6)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} helps the local community (7)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} helps people feel more connected (8)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} helps protect the environment (9)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} increases autonomy (10)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using ${Q105/ChoiceGroup/SelectedChoices} is compatible with my daily life (1)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} fits well with the way I like to live (2)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} is compatible with my values and beliefs (3)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} takes a lot of effort (4)	○	○	○	○	○
Using ${Q105/ChoiceGroup/SelectedChoices} is often frustrating (5)	○	○	○	○	○
I find it easy to use ${Q105/ChoiceGroup/SelectedChoices} (6)	○	○	○	○	○
Learning to use ${Q105/ChoiceGroup/SelectedChoices} was easy for me (7)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I would have no difficulty telling others about the results of using ${Q105/ChoiceGroup/SelectedChoices} (1)	○	○	○	○	○
I would have difficulty explaining what the consequences are of using ${Q105/ChoiceGroup/SelectedChoices} (2)	○	○	○	○	○
The results of using ${Q105/ChoiceGroup/SelectedChoices} are apparent to me (3)	○	○	○	○	○
It is easy to know if someone uses ${Q105/ChoiceGroup/SelectedChoices} (4)	○	○	○	○	○
It's not easy to see who's using ${Q105/ChoiceGroup/SelectedChoices} (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
It's possible to use ${Q105/ChoiceGroup/SelectedChoices} on a trial basis long enough to see what it can do (1)	○	○	○	○	○
People have confidence in using ${Q105/ChoiceGroup/SelectedChoices}. (2)	○	○	○	○	○

How important have these sources of information been in shaping your opinion of ${Q105/ChoiceGroup/SelectedChoices}?

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	Not at all important (5)
Specialist media e.g., transport-related magazines, websites (1)	○	○	○	○	○
General news media e.g., TV, radio, newspapers, websites (2)	○	○	○	○	○
Organisations, service providers, companies, local bodies (3)	○	○	○	○	○
Conversations with friends, family, colleagues (4)	○	○	○	○	○
Social media (5)	○	○	○	○	○
Seeing what others are doing (6)	○	○	○	○	○
Other [please specify] (7)	○	○	○	○	○

Page Break

To what extent do you agree with the following statements about ${Q105/ChoiceGroup/SelectedChoices}?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I often influence people's opinions about ${Q105/ChoiceGroup/SelectedChoices} (1)	○	○	○	○	○
I often persuade other people to use ${Q105/ChoiceGroup/SelectedChoices} that I like (3)	○	○	○	○	○
People I know pick ${Q105/ChoiceGroup/SelectedChoices} based on what I have told them (4)	○	○	○	○	○
Other people rarely come to me for advice about choosing ${Q105/ChoiceGroup/SelectedChoices} (5)	○	○	○	○	○
My opinion on ${Q105/ChoiceGroup/SelectedChoices} seems not to count with other people (6)	○	○	○	○	○

Display This Question:
If Have you ever used a peer-to-peer car sharing platform? = Yes, currently
Or Have you ever used a peer-to-peer car sharing platform? = In the past, but not now

Roughly how many people would you say you have spoken with (in person or via phone/internet) about ${Q105/ChoiceGroup/SelectedChoices} since you started using it?

_____

End of Block: Attributes of [P2P car share platform]

Start of Block: Personality

The next questions will help us understand a little about you.

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
It is pleasant to meet new people (1)	○	○	○	○	○
I regularly participate in social activity (2)	○	○	○	○	○
I see myself as someone who is outgoing (3)	○	○	○	○	○
I see myself as someone who is reserved (4)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I want to be among the first people to try a new technology (1)	○	○	○	○	○
I invest in new technologies soon after they become available for purchase (2)	○	○	○	○	○
I often take my time before making a decision to invest in a new technology (3)	○	○	○	○	○
I am often skeptical about new technologies (4)	○	○	○	○	○
I tend to invest in new technology once I have been convinced about the benefits of using it (5)	○	○	○	○	○
I rarely invest in new technologies (6)	○	○	○	○	○
I prefer to stick to existing technologies I am familiar with (7)	○	○	○	○	○

How important are these values as guiding principles in your life?

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	Not at all important (5)
Authority, the right to lead or command (1)	○	○	○	○	○
Influential, having impact on people and events (2)	○	○	○	○	○
Wealth, material possessions, money (3)	○	○	○	○	○
Social justice: correcting injustice, care for the weak (4)	○	○	○	○	○
A world at peace: free of war and conflict (5)	○	○	○	○	○
Protecting the environment: preserving nature (6)	○	○	○	○	○
Honouring parents and elders, showing respect (7)	○	○	○	○	○
Family security, safety for loved ones (8)	○	○	○	○	○
Self-discipline, self-restraint, resistance to temptation (9)	○	○	○	○	○
A varied life, filled with challenge, novelty and change (10)	○	○	○	○	○
An exciting life, stimulating experiences (11)	○	○	○	○	○
Curious, interested in everything, exploring (12)	○	○	○	○	○

End of Block: Personality

Start of Block: Socio economic

Finally, we have a few questions to help us understand your current situation a little.

What is your postcode sector? (The letters, and first 2 numbers that comprise your postcode, for example NR10 1xx)

How do you identify your gender?

Male / Female / Non - binary / Prefer not to say

How old are you?

Under 18 / 18 - 24 / 25 - 34 / 35 - 44 / 45 - 54 / 55 - 64 / 65 - 74 / 75 or older

What is your annual household income before taxes?
Under £9,500 / £9,500 - £15,499 / £15,500 - £24,999 / £25,000 - £49,999 / £50,000 - £74,999 / £75,000 or over / Don't know / Rather not say

Which best describes your current financial situation?
Healthy - I have money left at the end of the month for a few luxuries or to add to my savings / OK - I get by, but there's not a lot left by the time the basics are taken care of / Tight - I'm making ends meet, but only just / Struggling - I'm in danger of falling behind with bills or loan repayments / In trouble - I've missed loan repayments or household bills

Which of these best describes your current employment situation?
In paid employment (full or part-time) / Unemployed / Retired / On maternity leave / Looking after family or home / Full-time student / Long-term sick or disabled / On a government training scheme / Unpaid worker in family business / Working in an apprenticeship / Doing something else

Which is the highest educational or school qualification you have obtained?
PhD or equivalent doctoral level qualification / Masters or equivalent higher degree level qualification / Bachelors or equivalent first degree qualification / Post-secondary academic below-degree level qualification (up to 1 year) / Post-secondary academic below-degree level qualification (2 and more years) / Post-secondary vocational training (up to 1 year) / Post-secondary vocational training (2 and more years) / Completed secondary school / Completed primary school / None of the above

How many people are in your household?
1 / 2 / 3 / 4 / 5 / more than 5

Of these people, how many ...

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	More than 5 (7)
... Are pre-school children? (1)	○	○	○	○	○	○	○
... Are children who go to school? (2)	○	○	○	○	○	○	○
... Are over the age of 65? (3)	○	○	○	○	○	○	○
... Regularly spend time at home on week days? (4)	○	○	○	○	○	○	○

Do you personally have a smart phone?
Yes / No / Do not know

How often do you use the internet for your personal use?

Every day / Several times a week / Several times a month / Once a month / Less than once a month / Never use / No access at home, at work or elsewhere

Do you use any of the following social media? (Select all that apply)

None / Facebook / Twitter / Instagram / Linkedin / I don't know

End of Block: Socio economic

Start of Block: Follow up

Thank you! That's all our questions. We very much appreciate your help with our research project.

If you're interested, you can find further details about the project here: silci.org

We may want to contact you again to see if you would like to take part in follow-up research. May we contact you again solely for the purposes of this research project?

No / Yes, you can contact me by email on [enter email]

4.3. P2P ride sharing adopter survey

Start of Block: Travel behaviour

First, we would like to understand a little about your travel behaviours.

Do you commute between home and work?
Yes / No

Skip To: End of Block If Do you commute between home and work? = No

Which mode of transport do you most often use for your daily commute?
Car driver (own car) /Car driver (ride share/ carpool with others) / Car driver (car club) /Car passenger /Car passenger (ride share/ carpool with others) /Motorbike/ moped / Taxi / minicab / Bicycle / Metro/ tram/ light rail / Train / Intra-urban bus / Inter-urban bus (coach) / Walking

Display This Question:
If Which mode of transport do you most often use for your daily commute? = Car driver (ride share/ carpool with others)
Or Which mode of transport do you most often use for your daily commute? = Car passenger (ride share/ carpool with others)

You said that you commute with others, how many other people do you typically share your commute with? (excluding yourself)

What is the approximate distance, in miles, of your daily commute (i.e. your one-way journey from home to work)?

How long does your commute generally take (each way)?

Start of Block: Car ownership

Do you currently have a drivers license?

Yes / No / Don't know

How many cars does your household currently have? (please include lease cars or company cars where appropriate)

0 / 1 / 2 / 3 / 4 / More than 4

Skip To: End of Block If How many cars does your household currently have? (please include lease cars or company cars where... = 0

What is the make, model and year of your primary car?

Is your primary car ...
Petrol / Diesel / Hybrid / Electric / Don't know

Approximately how many miles do you drive in an average month in your car?
_____

How important were each of these when deciding to buy your car?

	Extremely important (13)	Very important (14)	Moderately important (15)	Slightly important (16)	Not at all important (17)
Purchase cost (1)	○	○	○	○	○
Running cost (2)	○	○	○	○	○
Fuel efficiency (3)	○	○	○	○	○
Style / design (4)	○	○	○	○	○
Comfort (5)	○	○	○	○	○
Brand reputation (6)	○	○	○	○	○
Space / functionality (7)	○	○	○	○	○
Reliability (8)	○	○	○	○	○
Safety (9)	○	○	○	○	○
Speed / performance (10)	○	○	○	○	○
Other (please specify) (11)	○	○	○	○	○

End of Block: Car ownership

Start of Block: Use of [P2P car share platform]

Next, we are going to ask you some questions about peer-to-peer ride sharing.

Have you ever used [a peer-to-peer ride sharing platform] / [Liftshare]?

Yes, currently / In the past, but not now / No, but I have heard of this / No, and I have never heard of this

Skip To: End of Block If Have you ever used a peer-to-peer car sharing platform? = No, and I have never heard of this
Skip To: End of Block If Have you ever used a peer-to-peer car sharing platform? = No, but I have heard of this

Have you ever used [a peer-to-peer ride sharing platform] / [Liftshare] to provide a lift for someone else? (i.e. as a driver?)
Yes / No / Do not know

Have you ever used [a peer-to-peer ride sharing platform] / [Liftshare] to receive a lift from someone else? (i.e. as a passenger?)
Yes / No / Do not know

Which do you do more, provide a lift or receive a lift via [a peer-to-peer ride sharing platform] / [Liftshare]?
Mostly provide / Provide and receive equally / Mostly receive

Display This Question:

If Have you ever used Liftshare to provide a lift for someone else? (i.e. as a driver?) = Yes

How often do you provide a lift through [a peer-to-peer ride sharing platform] / [Liftshare]?
Every day / several times a week / several times a month / once a month / less than once a month

Thinking about the last time you used Liftshare as a driver (i.e. to give a lift to someone else)...

	Responses
How many people were you travelling with?	
How long did your journey take (minutes)?	
How far was your journey (miles)?	

Would you say this journey is typical of how you use [a peer-to-peer ride sharing platform] / [Liftshare]?
Yes / No

Do you make this journey, or a similar journey regularly? If so, please specify how often you make a journey like this
Yes, I make this journey regularly (please specify frequency) / No

Thinking about the last journey you made using Liftshare as a driver, why did you choose to use Liftshare for this journey? Choose all that apply.
It was quicker than alternatives / It was cheaper than alternatives / It was more social than alternatives / It was easier than alternatives / It was more convenient than alternatives / Other (Please specify)
_____

Thinking about the last journey you made using Liftshare as a driver, if a match had not been available through Liftshare, how would you have made this journey?

Bicycle (my own) / Bicycle (bike sharing scheme) / intra - urban bus / Car driver (own car) / Car driver (car club car) / Car passenger (either own or car club car) / Motorbike / moped / Taxi / minicab / Inter-urban bus (coach) / Train / Walking

Display This Question:

If Have you ever used Liftshare to receive a lift from someone else? (i.e. as a passenger?) = Yes

How often do you provide a lift through [a peer-to-peer ride sharing platform] / [Liftshare]?
Every day / several times a week / several times a month / once a month / less than once a month

Thinking about the last time you used Liftshare as a driver (i.e. to give a lift to someone else)...

	Responses
How many people were you travelling with?	
How long did your journey take (minutes)?	
How far was your journey (miles)?	

Would you say this journey is typical of how you use [a peer-to-peer ride sharing platform] / [Liftshare]?
Yes / No

Do you make this journey, or a similar journey regularly? If so, please specify how often you make a journey like this
Yes, I make this journey regularly (please specify frequency) / No

Thinking about the last journey you made using Liftshare as a passenger, why did you choose to use Liftshare for this journey? Choose all that apply.
It was quicker than alternatives / It was cheaper than alternatives / It was more social than alternatives / It was easier than alternatives / It was more convenient than alternatives / Other (Please specify)
_____

Thinking about the last journey you made using Liftshare as a driver, if a match had not been available through Liftshare, how would you have made this journey?

Bicycle (my own) / Bicycle (bike sharing scheme) / intra - urban bus / Car driver (own car) / Car driver (car club car) / Car passenger (either own or car club car) / Motorbike / moped / Taxi / minicab / Inter-urban bus (coach) / Train / Walking

On average, how many different Liftshare users do you travel in a car with in a month? (With yourself as driver or passenger)
None / 1 / 2 / 3 / 4 / 5 / more than 5

Of these people, how many times do you travel with each of them?

	Number of times you travel with this person
Person 1	
Person 2	
Person 3	
Person 4	
Person 5	

How has your monthly car driver mileage changed because of joining Liftshare?
Decreased a lot / Decreased a little / Stayed the same (no change) / Increased a little / Increased a lot

Now, we are going to ask you what you think about certain attributes of [P2P ride sharing platform / Liftshare]

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
The other users of [P2P ride sharing platform / Liftshare] are truthful in dealing with one another (1)	○	○	○	○	○
The other users of [P2P ride sharing platform / Liftshare] will not take advantage of me (2)	○	○	○	○	○
[P2P ride sharing platform / Liftshare] provides a robust and safe environment in which I can use the service (3)	○	○	○	○	○
Overall, [P2P ride sharing platform / Liftshare] is trustworthy (4)	○	○	○	○	○
The other users of [P2P ride sharing platform / Liftshare] are trustworthy (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using [P2P ride sharing platform / Liftshare] makes a good impression on others (1)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] is too expensive (2)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] is a status symbol (3)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] is convenient (4)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] helps save money (5)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] helps address climate change (6)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] helps the local community (7)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] helps people feel more connected (8)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] helps protect the environment (9)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] increases autonomy (10)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Using [P2P ride sharing platform / Liftshare] is compatible with my daily life (1)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] fits well with the way I like to live (2)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] is compatible with my values and beliefs (3)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] takes a lot of effort (4)	○	○	○	○	○
Using [P2P ride sharing platform / Liftshare] is often frustrating (5)	○	○	○	○	○
I find it easy to use [P2P ride sharing platform / Liftshare] (6)	○	○	○	○	○
Learning to use [P2P ride sharing platform / Liftshare] was easy for me (7)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I would have no difficulty telling others about the results of using [P2P ride sharing platform / Liftshare] (1)	○	○	○	○	○
I would have difficulty explaining what the consequences are of using [P2P ride sharing platform / Liftshare] (2)	○	○	○	○	○
The results of using [P2P ride sharing platform / Liftshare] are apparent to me (3)	○	○	○	○	○
It is easy to know if someone uses [P2P ride sharing platform / Liftshare] (4)	○	○	○	○	○
It's not easy to see who's using [P2P ride sharing platform / Liftshare] (5)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
It's possible to use [P2P ride sharing platform / Liftshare] on a trial basis long enough to see what it can do (1)	○	○	○	○	○
People have confidence in using [P2P ride sharing platform / Liftshare]. (2)	○	○	○	○	○

How important have these sources of information been in shaping your opinion of [P2P ride sharing platform / Liftshare]?

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	Not at all important (5)
Specialist media e.g., transport-related magazines, websites (1)	○	○	○	○	○
General news media e.g., TV, radio, newspapers, websites (2)	○	○	○	○	○
Organisations, service providers, companies, local bodies (3)	○	○	○	○	○
Conversations with friends, family, colleagues (4)	○	○	○	○	○
Social media (5)	○	○	○	○	○
Seeing what others are doing (6)	○	○	○	○	○
Other [please specify] (7)	○	○	○	○	○

Page Break

To what extent do you agree with the following statements about [P2P ride sharing platform / Liftshare]?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I often influence people's opinions about [P2P ride sharing platform / Liftshare] (1)	○	○	○	○	○
I often persuade other people to use [P2P ride sharing platform / Liftshare] that I like (3)	○	○	○	○	○
People I know pick [P2P ride sharing platform / Liftshare] based on what I have told them (4)	○	○	○	○	○
Other people rarely come to me for advice about choosing [P2P ride sharing platform / Liftshare] (5)	○	○	○	○	○
My opinion on [P2P ride sharing platform / Liftshare] seems not to count with other people (6)	○	○	○	○	○

Display This Question:
If Have you ever used a peer-to-peer car sharing platform? = Yes, currently
Or Have you ever used a peer-to-peer car sharing platform? = In the past, but not now

Roughly how many people would you say you have spoken with (in person or via phone/internet) about [P2P ride sharing platform / Liftshare] since you started using it?

_____

End of Block: Attributes of [P2P car share platform]

Start of Block: Personality

The next questions will help us understand a little about you.

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
It is pleasant to meet new people (1)	○	○	○	○	○
I regularly participate in social activity (2)	○	○	○	○	○
I see myself as someone who is outgoing (3)	○	○	○	○	○
I see myself as someone who is reserved (4)	○	○	○	○	○

To what extent do you agree with the following?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I want to be among the first people to try a new technology (1)	○	○	○	○	○
I invest in new technologies soon after they become available for purchase (2)	○	○	○	○	○
I often take my time before making a decision to invest in a new technology (3)	○	○	○	○	○
I am often skeptical about new technologies (4)	○	○	○	○	○
I tend to invest in new technology once I have been convinced about the benefits of using it (5)	○	○	○	○	○
I rarely invest in new technologies (6)	○	○	○	○	○
I prefer to stick to existing technologies I am familiar with (7)	○	○	○	○	○

How important are these values as guiding principles in your life?

	Extremely important (1)	Very important (2)	Moderately important (3)	Slightly important (4)	Not at all important (5)
Authority, the right to lead or command (1)	○	○	○	○	○
Influential, having impact on people and events (2)	○	○	○	○	○
Wealth, material possessions, money (3)	○	○	○	○	○
Social justice: correcting injustice, care for the weak (4)	○	○	○	○	○
A world at peace: free of war and conflict (5)	○	○	○	○	○
Protecting the environment: preserving nature (6)	○	○	○	○	○
Honouring parents and elders, showing respect (7)	○	○	○	○	○
Family security, safety for loved ones (8)	○	○	○	○	○
Self-discipline, self-restraint, resistance to temptation (9)	○	○	○	○	○
A varied life, filled with challenge, novelty and change (10)	○	○	○	○	○
An exciting life, stimulating experiences (11)	○	○	○	○	○
Curious, interested in everything, exploring (12)	○	○	○	○	○

End of Block: Personality

Start of Block: Socio economic

Finally, we have a few questions to help us understand your current situation a little.

What is your postcode sector? (The letters, and first 2 numbers that comprise your postcode, for example NR10 1xx)

How do you identify your gender?

Male / Female / Non - binary / Prefer not to say

How old are you?

Under 18 / 18 - 24 / 25 - 34 / 35 - 44 / 45 - 54 / 55 - 64 / 65 - 74 / 75 or older

What is your annual household income before taxes?
Under £9,500 / £9,500 - £15,499 / £15,500 - £24,999 / £25,000 - £49,999 / £50,000 - £74,999 / £75,000 or over / Don't know / Rather not say

Which best describes your current financial situation?
Healthy - I have money left at the end of the month for a few luxuries or to add to my savings / OK - I get by, but there's not a lot left by the time the basics are taken care of / Tight - I'm making ends meet, but only just / Struggling - I'm in danger of falling behind with bills or loan repayments / In trouble - I've missed loan repayments or household bills

Which of these best describes your current employment situation?
In paid employment (full or part-time) / Unemployed / Retired / On maternity leave / Looking after family or home / Full-time student / Long-term sick or disabled / On a government training scheme / Unpaid worker in family business / Working in an apprenticeship / Doing something else

Which is the highest educational or school qualification you have obtained?
PhD or equivalent doctoral level qualification / Masters or equivalent higher degree level qualification / Bachelors or equivalent first degree qualification / Post-secondary academic below-degree level qualification (up to 1 year) / Post-secondary academic below-degree level qualification (2 and more years) / Post-secondary vocational training (up to 1 year) / Post-secondary vocational training (2 and more years) / Completed secondary school / Completed primary school / None of the above

How many people are in your household?
1 / 2 / 3 / 4 / 5 / more than 5

Of these people, how many ...

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	More than 5 (7)
... Are pre-school children? (1)	○	○	○	○	○	○	○
... Are children who go to school? (2)	○	○	○	○	○	○	○
... Are over the age of 65? (3)	○	○	○	○	○	○	○
... Regularly spend time at home on week days? (4)	○	○	○	○	○	○	○

Do you personally have a smart phone?
Yes / No / Do not know

How often do you use the internet for your personal use?

Every day / Several times a week / Several times a month / Once a month / Less than once a month / Never use / No access at home, at work or elsewhere

Do you use any of the following social media? (Select all that apply)

None / Facebook / Twitter / Instagram / Linkedin / I don't know

End of Block: Socio economic

Start of Block: Follow up

Thank you! That's all our questions. We very much appreciate your help with our research project.

If you're interested, you can find further details about the project here: silci.org

We may want to contact you again to see if you would like to take part in follow-up research. May we contact you again solely for the purposes of this research project?

No / Yes, you can contact me by email on [enter email]

Appendix 5: Focus group additional details

5.1. Focus group topic guides

5.1.1. Commuters

Introduction

Welcome and overview of topic

Welcome

The purpose of this focus group is to understand people's motivations and decisions to use P2P ride sharing.

You were invited because you participated in an online survey about [P2P ride sharing].

Ground rules

You all read a consent form, to reiterate you can choose to withdraw from the focus group at any point.

The session will be recorded, but all your comments will be anonymised.

There is a chat function in Microsoft Teams. To avoid separate discussions happening in parallel, we will stick to primarily using the audio. However if you are struggling with your internet connection at all, then please feel free to use the chat function.

At the end of this session you will be given £25 Amazon e-gift card as a thank you for your participation. This will be emailed to you [soon].

There are no wrong answers, just different points of view. Please feel free to share your point of view even if it differs from what others have said. Keep in mind that we're just as interested in negative comments as positive comments.

Opening question

Introduce yourself and share how you first started using P2P ride sharing, and what experience you have with it

Discussion questions

To address the following aims:

- What is the role of institutional factors (pressures) in deciding to use, or not use, P2P mobility? – (commuters only)
- Where is the agency? - (commuters only)
- What is the role of contextual factors in deciding to use, or not use, P2P mobility?
- Why do people choose to use P2P mobility instead of other modes of transport?
-

Some of you mentioned using P2P ride sharing for commuting, what influenced your decision to use P2P ride sharing?

- *Some of you mentioned workplace expectations/culture/policy, could you elaborate on that?*

What made you choose to use P2P ride sharing instead of other modes?

- *What are some of the benefits of using P2P ride sharing?*
- *Some of you mentioned [cost/ease/other perceived benefits], what do you all think about that?*

To address the following aims:

- What role does trust in others, and trust in the platform, play in deciding to use, or not use P2P mobility?
- What role does sociality, and relationships with others, play in deciding to use, or not use P2P mobility?

The next couple of discussion points ask about what was normal for you before the crisis. We will have the chance to talk about if and how your perceptions may be different now, but for the next discussion points let's try to focus on your experiences before March.

[Hopefully some people will mention that they ride share with colleagues, so these discussion questions explore the role of trust and relationships]

Who uses P2P ride sharing with colleagues?

- *How important is it that you already know the people you rideshare with?*
- *What role does trust have?*

Something about sociality and needing to get on with people who you share rides with

Does anyone use P2P ride sharing with people that they met via a platform or an app?

- *How important is the reputation of the platform or app?*
- *How important is it that you trust the platform or app?*
- *What would make you more likely to trust a platform or an app?*

Some of the themes that have come up during these discussions are around [trust / social interactions / relationships / independence etc].

Has the coronavirus pandemic influenced how you think about [whatever they've been talking about]?

Has the coronavirus pandemic influenced how you think about P2P ride sharing at all?

5.1.2. Car-free households

Introduction

Welcome and overview of topic

Welcome

The purpose of this focus group is to understand people's motivations and decisions to use P2P ride sharing.

You were invited because you participated in an online survey about [P2P ride sharing].

Ground rules

You all read a consent form, to reiterate you can choose to withdraw from the focus group at any point

The session will be recorded, but all your comments will be anonymised.

There is a chat function in Microsoft Teams. To avoid separate discussions happening in parallel, we will stick to primarily using the audio. However if you are struggling with your internet connection at all, then please feel free to use the chat function.

At the end of this session you will be given £25 Amazon e-gift card as a thank you for your participation. This will be emailed to you [soon].

There are no wrong answers, just different points of view. Please feel free to share your point of view even if it differs from what others have said. Keep in mind that we're just as interested in negative comments as positive comments.

Opening question

Introduce yourself and share how you first started using P2P ride sharing, and what experience you have with it

Discussion questions

To address the following aims:

- What is the role of contextual factors in deciding to use, or not use, P2P mobility?
- Why do people choose to use P2P mobility instead of other modes of transport?

What kinds of journeys do you use P2P ride sharing for?

- *Why do you decide to use P2P ride sharing for these kinds of journeys?*
- *What do you think are the benefits of using P2P ride sharing, instead of other modes?*
- *Some of you mentioned [cost/ease/other perceived benefits], what do you all think about that?*
- *Why did you choose not to have a car? [cost, environmental reasons, no need]*

To address the following aims:

- What role does trust in others, and trust in the platform, play in deciding to use, or not use P2P mobility?
- What role does sociality, and relationships with others, play in deciding to use, or not use P2P mobility?

The next couple of discussion points ask about what was normal for you before the crisis. We will have the chance to talk about if and how your perceptions may be different now, but for the next discussion points let's try to focus on your experiences before March.

[Car-free household respondents will most likely always be a peer-service user, i.e. passenger, and so dependent on other users]

How important is it that you know the people you shared rides with?

- *Would your perception of this be different do you think if you were the driver?*

How important is the reputation of the platform or app?

Some of the themes that have come up during these discussions are around [trust / social interactions / relationships / independence etc].

Has the coronavirus pandemic influenced how you think about [whatever they've been talking about]?

Has the coronavirus pandemic influenced how you think about P2P ride sharing at all?

5.1.3. P2P car sharers

Introduction

Welcome and overview of topic

Welcome

The purpose of this focus group is to understand people's motivations and decisions to use P2P car sharing.

You were invited because you participated in an online survey about [P2P car sharing].

Ground rules

You all read a consent form, to reiterate you can choose to withdraw from the focus group at any point

The session will be recorded, but all your comments will be anonymised.

There is a chat function in Microsoft Teams. To avoid separate discussions happening in parallel, we will stick to primarily using the audio. However if you are struggling with your internet connection at all, then please feel free to use the chat function.

At the end of this session you will be given £25 Amazon e-gift card as a thank you for your participation. This will be emailed to you [soon].

There are no wrong answers, just different points of view. Please feel free to share your point of view even if it differs from what others have said. Keep in mind that we're just as interested in negative comments as positive comments.

Opening question

Introduce yourself and share how you first started using P2P car sharing, and what experience you have with it

Discussion questions

To address the following aims:

- What is the role of contextual factors in deciding to use, or not use, P2P mobility?
- Why do people choose to use P2P mobility instead of other modes of transport?

[For peer-service users]

What kinds of journeys do you use P2P car sharing for?

- *Why do you decide to use P2P car sharing for these kinds of journeys?*
- *What do you think are the benefits of using P2P car sharing, instead of other modes?*
- *Some of you mentioned [cost/ease/other perceived benefits], what do you all think about that?*
- *Do you own a car? [If not, why do you choose not to]? [cost/convenience/environment etc]*

[For peer-service providers]

Why do you choose to use P2P car sharing?

- *Some of you mentioned [perceived benefits/extra income/ capitalise idle capacity], could you elaborate? What do you all think?*

Have you used P2P car sharing as a peer-service user also?

- *If so, [see questions above]*

To address the following aims:

- What role does trust in others, and trust in the platform, play in deciding to use, or not use P2P mobility?
- What role does sociality, and relationships with others, play in deciding to use, or not use P2P mobility?

The next couple of discussion points ask about what was normal for you before the crisis. We will have the chance to talk about if and how your perceptions may be different now, but for the next discussion points let's try to focus on your experiences before March.

[For both]

How important is the reputation of the platform or the app?

[For peer-service users]

In what ways does P2P car sharing appeal to you?

[For peer-service providers]

- *Do you have any concerns renting your car to others?*
- *Do you decide who to allow to book your car?*
- *If so, how do you decide? What are you looking for in a potential renter's profile?*

Some of the themes that have come up during these discussions are around [trust / social interactions / relationships / independence etc].

Has the coronavirus pandemic influenced how you think about [whatever they've been talking about]?

5.2. A priori codes used for transcription coding

The a priori codes presented in the below table were informed by prior expectations related to the hypotheses and existing literature on trust, the theoretical framework used to frame this chapter, and the data collected in chapter 4.

Step 1: Initial coding frame (a priori codes) for P2P ride sharing focus groups			
Theme (from topic guide)	**Code (Node)**	**Definition**	**Notes**
Trust	People	Trust in other users of the platform	
	Product	Trust in the vehicle itself	
	Platform	Trust in the mediating platform	
	Ability	Having correct skills to properly and safely complete transaction	
	Integrity	Keeping word/ general reputation	
	Benevolence	Keeps others interests in mind / user support/ 3rd party access to data / exploiting suppliers	
Sociality and Relationships	Knowing others previously	Relationship with other user prior to using ride sharing	Knowing others previously / not knowing others previously / positive or negative
	Compatibility	Get on well with others / respectful / easy to be with	
	Altruism	Helps others by providing rides	Without expectation that they will "repay the favour"
	Community	Sense of community	
Contextual factors	(Expect these to come from the data – i.e. in vivo codes		
Institutional factors	Workplace policy	Policies in the workplace regarding the use of ride sharing	Only applicable to focus groups with commuters

	Workplace culture	Culture, or norms in the workplace regarding the use of ride sharing	Only applicable to focus groups with commuters
Use of P2P mobility	Commuting	Use ride sharing for commuting	Categorise use for comparison across focus groups
	One-off	Use ride sharing for one off longer journeys	Categorise use for comparison across focus groups
	Alternatives	Discussion of alternative ways of travelling	Hypothetical or previous / positive or negative
Motivations	Financial	Motivated to participate for financial reasons	I expect these to be linked to the contextual factors to some degree
	Environmental	Motivated to participate for environmental reasons	
	Social	Motivated to participate for social reasons	Potential link to sociality and relationships
	Institutional	Motivated to participate for institutional (workplace) reasons	Strong link to institutional factors