**Working Paper**

MaaSLab-WP-18-01

# Exploring Individual Preferences for Mobility as a Service Plans: A Mixed Methods Approach

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July, 2018

To cite this paper: Matyas, M. and Kamargianni, M. (2018) Exploring Individual Preferences for Mobility as a Service Plans: A Mixed Methods Approach. MaaSLab Working Paper Series Paper No. 18-01.

**Abstract:**
As the number of Mobility as a Service (MaaS) applications have started to grow, it is of high importance to gain a deeper understanding of the different aspects of this concept. With many different business models and product designs emerging, there is still little knowledge on what consumer preferences are, and how users navigate between various MaaS offerings. With this in mind, the main objective of this paper is to contribute to research about user preferences for MaaS products and more specifically for plans. In doing so, the paper aims to provide insights about what modes and features people prefer in their plans and what individual characteristics have a significant effect on choosing across MaaS plans. Taking London as a case study, an explanatory sequential mixed methods research design is used, in which the quantitative phase is carried out first, followed by the qualitative phase to help explain the quantitative results and provide additional insights. The quantitative phase includes an online survey and stated preference experiments followed by a MaaS plan choice model, while the qualitative comprises of in-depth interviews and thematic analysis. The results of the study provide interesting insights to consumer behavior and can be valuable to the private and public sector as well as the research community.

Keywords: Mobility as a Service, MaaS, MaaS products, plans, mixed methods, bundles, choice model, interview

## 1 Introduction

Riding the wave of technological advancements, the widespread availability of ICT devices and the sharing economy, the past decade has seen the introduction of a number of new mobility services. Car sharing, bike sharing, on demand transport, and ridehailing are now commonplace in many urban areas. Additionally, the next generation of technological innovations such as autonomous vehicles and drones are now being tested. With the number of overall transport options available to travelers continuously growing, it is increasingly difficult for users to navigate through the silos of different information sources, mobile applications, tickets and journey planners that are necessary for them to get around (Kamargianni et al., 2015). The need for a single, integrated, user-friendly system has led to the birth of the Mobility as a Service (MaaS) concept, which aims to decrease the pain points that result from multimodal journeys.

The definition of MaaS has been widely debated, but in this paper, we follow the definition provided by MaaSLab (2018), according to which "Mobility-as-a-Service is a user-centric, intelligent mobility management and distribution system, in which an integrator brings together offerings of multiple mobility service providers, and provides end-users access to them through a digital interface, allowing them to seamlessly plan and pay for mobility." From the users' point of view, the service is accessible through a digital interface or smartphone app, where they can purchase MaaS products, such as monthly subscription plans (Kamargianni, et al., 2016; Hietanen, 2016; Hensher, 2017). MaaS subscription plans build on the concept of product bundling, which is the practice of marketing and selling two or more products or services in a package for a special price (Guiltinan, 1987). Packaging transport services via MaaS may be new, but the method is analogous to bundles in other sectors, such as telecommunication (e.g. TV + Internet + Landline plans).

The MaaS concept is still not at its maturity and there are only a handful of applications. Commercial applications are available in Helsinki and the West Midlands and Antwerp run by Whim from MaaS Global, while pilots have been tested in Sweden, Austria and Germany (for detailed reviews of MaaS and MaaS-like services, please refer to the works from Kamargianni, et al., 2016; Jittrapirom, et al., 2017; Magoutas, et al., 2017; Georgakis, et al., 2018). The available services are frequently amending their product offerings, which suggests that there is still much to learn about the exact demand and user preferences for these. There is a small, but growing number of research papers that tackle this topic (Matyas & Kamargianni, 2017; Ho, et al., 2017; González Alonso, et al., 2017; Sochor, et al., 2015). However, the user preferences for different product attributes and the behavioral and societal barriers to consumer adoption are still largely unknown.

With this in mind, the objective of this paper is to contribute to the understanding of user preferences for MaaS plans. More specifically, the two main research questions are as follows: (1) What modes and features do people favor in their MaaS plans and how do they evaluate between them? (2) What individual characteristics have a significant effect on choosing MaaS plans?

To answer these questions an explanatory sequential mixed methods research design is used. This two-step approach involves collecting and analyzing quantitative data first, followed by an in-depth qualitative element. In the first, quantitative, phase of the study, an online survey, including a stated preference experiment about MaaS plans is carried out. The data is analyzed using a mixed logit model (MMNL) to explore individuals' preferences towards the various elements of MaaS plans. The second, qualitative, phase is based on in-depth semi-structured interviews with survey participants and the data is analyzed through thematic analysis. The qualitative analysis helps explain the mechanisms or reasons behind the trends and relationships observed in the quantitative data and also provides additional insights. The case study city is London.

The remainder of the paper is structured as follows. Section 2 provides a literature review about existing research on MaaS and mixed methods research within transport demand analysis in order to

demonstrate the contribution of this paper. Section 3 gives an overview of the methodology and describes the design quantitative data collection tool. Section 4 provides the quantitative data analysis and model results, while section 5 describes the qualitative data collection, analysis and results. Finally, section 6 provides some discussion and conclusions.

## 2 Literature

### *2.1 Mobility as a Service Literature*

Due to the relative novelty of the Maas concept, the available papers on the topic are fairly limited. However, as the concept gains wider acceptance, the number of both academic and grey literature getting published each year is constantly growing. The topics explored include business models (Kamargianni & Matyas, 2017; Ebrahimi, et al., 2018), impacts on specific transport modes (Hensher, 2017; Smith, et al., 2017), end user demand (Sochor, et al., 2015; Ho, et al., 2017; Matyas & Kamargianni, 2017), governmental role (Heikkilä, 2014), topology of services (Kamargianni, et al., 2016; Jittrapirom, et al., 2017; Sochor, et al., 2017), issues around implementation of MaaS (Mulley, 2017; Wong, et al., 2017). Most existing literature consists of thought pieces and reviews. Some examples from academic literature include studies, which review MaaS-like, integrated services in order to highlight key characteristics (Jittrapirom, et al., 2017). Others, take it one step further and attempt to classify these services based on the level of integration (Kamargianni, et al., 2016; Sochor, et al., 2017). There are also studies, which provide thoughts on one aspect of MaaS, such as the conditions of its implementation (Li & Voege, 2017) or the way various modes could be offered under MaaS (Hensher, 2017). Grey literature also contributes a number of thought pieces and reviews (Datson, 2016; Cubic Transportation Systems, 2016).

Even though most studies available are not based on empirical findings, there are a handful of such papers available. These take either quantitative or qualitative approaches, or a combination of the two. Looking at those that collect and analyze quantitative data, these studies use stated preference methods to analyze demand for- and the effect of MaaS (Matyas & Kamargianni, 2017; Ho, et al., 2017; González Alonso, et al., 2017). Examining these studies in more detail, González Alonso, et al. (2017) focus on whether MaaS could create modal shift. They do this, by carrying out an on-line survey in Amsterdam with 797 respondents, in which participants are asked to choose transport modes in nine hypothetical situations. Using the mode choices, a modal portfolio is created for each respondent. Next, for each modal portfolio, the 'MaaS-prone' behavior is investigated using basic statistical methods, based on factors such as public transport subscription, mobility app usage and opinion towards payment via applications. The study concludes, that multimodal users are most prone to adopt MaaS. One interesting element of this study, is that it does not directly ask respondents anything about MaaS. Rather, they use certain characteristics of individuals, namely public transport subscription, mobility app usage and opinion towards payment via applications, as a proxy of their willingness to adopt MaaS. In contrast, other studies collect data when respondents are directly asked about their preferences for MaaS (Matyas & Kamargianni, 2017; Ho, et al., 2017). As the Matyas and Kamargianni (2017) study is based on the same quantitative data collection as this paper, this will not be discussed further in this literature review. Looking at another study, Ho et al. (2017) also design a stated preference experiment, which includes asking respondents directly about their preferences for MaaS products. The SP presented respondents with a choice between two fixed plans, a pay-as-you-go and a no choice (status quo) option. The modes that were included in the plans are public transport, car sharing, taxi and Uberpool. The survey was carried out in Sydney, Australia as a computer assisted personal interview (CAPI) with a sample of 252 people. To analyze the collected data, discrete choice models were used to get willingness to pay values for the different modes.

Turning to the studies using qualitative methods, these use individual meetings and semi-structured interviews to examine various aspect of MaaS (Smith, et al., 2017; Smits, et al., 2017). Both studies

are more focused on the supply side, and conduct interviews with stakeholders in the MaaS ecosystem. Smith et al. (2017a) conduct interviews with 19 actors in order to explore how MaaS could develop and how the future of public transport could be affected; while Smith et al (2017b) carry out 10 interviews to identify aspect that are important when procuring MaaS. Finally, there are those studies that use a mixed methods approach to explore various aspects of MaaS. A number of studies have resulted from the UbiGo MaaS field trial (Sochor, et al., 2015; Karlsson, et al., 2016). In this trial, public transport, car sharing, taxi, bike sharing and car rentals were offered to users as subscription plans. 89 households with 195 users subscribed for monthly plans including a personalized combination of- and credit for- the various travel services. The prepaid tailored monthly plans were determined in time or distance for each mode and the combined subscription was cheaper than each element individually. Credit could be topped up or rolled over and subscriptions modified. A mobility broker handled everything for the users to make it a seamless experience. As this was an actual trial, different provision structures/prices could not be tested (as it is possible the case of SPs). However, the project did result in a number of studies on various elements of MaaS. Sochor et al. (2015) used information collected through the pilot to identify matches and mismatches between the expectation and experiences of three stakeholder groups: the users of the service, the commercial actors and society. Karlsson et al. (2016) used a mixed methods data collection, which involved questionnaires, travel diaries, interviews and focus groups with participants of the trial. The study involved basic statistical analysis for the quantitative data and thematic analysis and selection of quotes for the qualitative element. The qualitative and quantitative data were analyzed alongside each other. Their findings indicate an overall positive outcome from the trial, however a number of barriers were also recognized.

Overall, there is still only a limited amount of academic literature on MaaS, especially those that focus on the end user and use empirical evidence. This study aims to contribute to these studies. It adds to the existing literature by taking a mixed methods approach that uses both discrete choice models alongside in-depth interviews. It also provides insights into a new city, one, that has very different characteristics that the previously explored ones.

### *2.2 Mixed Methods in Travel Demand Analysis*

Historically quantitative and qualitative methods were seen as incompatible approaches. Researchers would frequently advocate one of the two methods and disparage the value of the alternative one (Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 2010). However, since the 1980s[1], studies have been applying these methods together with increasing frequency (Creswell, 2003; Creswell & Plano Clark, 2007).Using a combination of quantitative and qualitative elements, falls under the mixed-method approach, in which multiple research methodologies are combined in one study. Mixed-method approaches have been shown to provide significant added value to studies, especially when the phenomenon under study is complex (Morse, 2016). They are able to provide a more holistic understanding of the subject and enhance description and explanation. In many cases, there is a core component, that is supplemented with an additional component to improve the depth of the research findings. Using multiple methods to examine the same subject, can also increase the validity of the results (Hurmerinta-Peltomaki & Nummela, 2006). Even though mixed methods provide a number of benefits, its popularity is limited by the fact that its implementation requires a large amount of resources, including time, financial means and skills (McKim, 2017).

Using a combination of quantitative and qualitative elements is frequently used in subject areas such as psychology, sociology and education. It is less common in the field of transportation, which is still dominated by quantitative-only studies. However, since the pivotal reviews of Grosvenor (2000) and Clifton and Handy (2003), qualitative research, and as a result mixed methods, have increasingly

[1] Mixed methods have been seen since the 1950s, but they are formally used since the 1980s (Creswell and Plano Clark, 2007)

gained traction (Aicart, et al., 2016). Qualitative elements can be used before the quantitative elements to examine how best to design the qualitative surveys; or after, to better explain the results that surface from the analysis (Hesse-Biber, 2010). Qualitative elements can bring a number of benefits to traditional qualitative surveys in the field of transportation. Grosvenor (2000) points out, that quantitative and qualitative research should not be viewed as substitutes, but rather as complements that can add to the understanding of travel behavior. Also, qualitative methods can be used to improve design and extend interpretation of quantitative surveys (Clifton & Handy, 2003). Looking at more recent viewpoints, mixed methods have been recognized as having the most potential to provide a well-rounded understanding of choices and behavior (Clifton, 2013; Carrasco & Lucas, 2015).

We can take a closer look at the available literature breaking it down by the samples used for the two studies. On the one hand, mixed-methods studies can be conducted with the respondents to the qualitative and quantitative elements being different people (e.g. Baslington, 2008; Aarhaug & Elvebakk, 2015; Karndacharuk et al., 2016). These studies use various population groups to examine the same topic from different viewpoints and with the two methods. For example, Baslington (2008) carries out a travel diary with children about their route choices to school and then conducts a follow-up interview with parents in the same areas. In a more recent study, Karndacharuk et al. (2016) carry out a survey regarding shared street space with residents, while also conducting interviews with transportation experts. On the other hand, it is also possible, that the same participants are used for both the quantitative and qualitative elements, this way allowing for the follow-up questions to help understand the reasons behind the responses to the quantitative questions. A widely cited study by Handy and Clifton (2001) carry out a mail out mail back household travel survey about travel mode choice for shopping trips. Following the survey, they use a selection of respondents and through focus groups further explore the factors, motivations and attitudes behind the choices seen in the survey responses. Other studies use in-depth interviews with a sample of survey respondents to gain deeper insights into the outcomes of the quantitative results (e.g. Schneider, 2011; Pooley et al., 2013).

Looking more specifically at the qualitative elements, Aicart et al. (2016) provide a comprehensive overview of recent qualitative studies in the field of travel behavior. They find that in-depth interviews are the most common method of qualitative data collection, while focus groups come second. The two methods are ideal in different situations. Focus groups should be used when the researcher is interested in understanding the interactions between individuals (such as empathy or disagreement) or when the group setting may bring out more insights (Grosvenor, 2000; Lazar, et al., 2017). However, individuals may be less keen to share their views when others are present, especially when they may contradict the general tendency of the group. Personal interviews remove the normative pressures and allows for flexible types of information to be collected (Clifton & Handy, 2003). In their review, Aicart et al. (2016) also examine the analysis techniques that studies employ when dealing with qualitative data. They find that the most frequently applied method is thematic analysis, in which the data is explored, to identify, analyze, organize and describe the themes and patterns that emerge (Braun & Clark, 2006; Nowell, et al., 2017). The second most common approach is using Grounded Theory (Glaser & Strauss, 1967), which uses emerging patterns in data to generate theories, followed by the third, case studies, which studies a person or group over time.

The above reviewed literature demonstrates that there is significant value of conducting a quantitative-qualitative mixed methods study. So far, there is only one MaaS paper that fully incorporates both quantitative and qualitative elements. However, this paper is based on data from a trial (where attributes and levels are fixed to the ones tested in the trial) and their analysis is fairly limited. This paper adds to the mixed methods literature on travel behavior by focusing on a previously little explored topic. Second, it adds to the literature about MaaS, by examining demand using mixed methods with data from an experiment where different product levels can be tested.

## 3 Methodological Overview and Data

### *3.1 Study Overview*

The type of mixed method used in this study is an explanatory sequential design, in which the quantitative phase is carried out first, followed by the qualitative phase to help explain the quantitative results (Creswell, 2015). This method is ideal for research with a quantitative focus, where the interpretation of the statistical results need additional refinements. By using qualitative methods to follow up quantitative results, participant views on critical areas can be explored in more depth. Following the guidelines presented in Ivankova et al. (2006) and Creswell (2015), the visual model of procedures followed in this study is illustrated in Figure 1. The model portrays the research activities in chronological order, alongside the products (specific outcomes) resulting from each step. In the figure, boxes are used for data collection and analysis elements, while ovals indicate interpretation sections, where the quantitative and qualitative phases connect with each other. QUANTITATIVE is capitalized to indicate its priority.

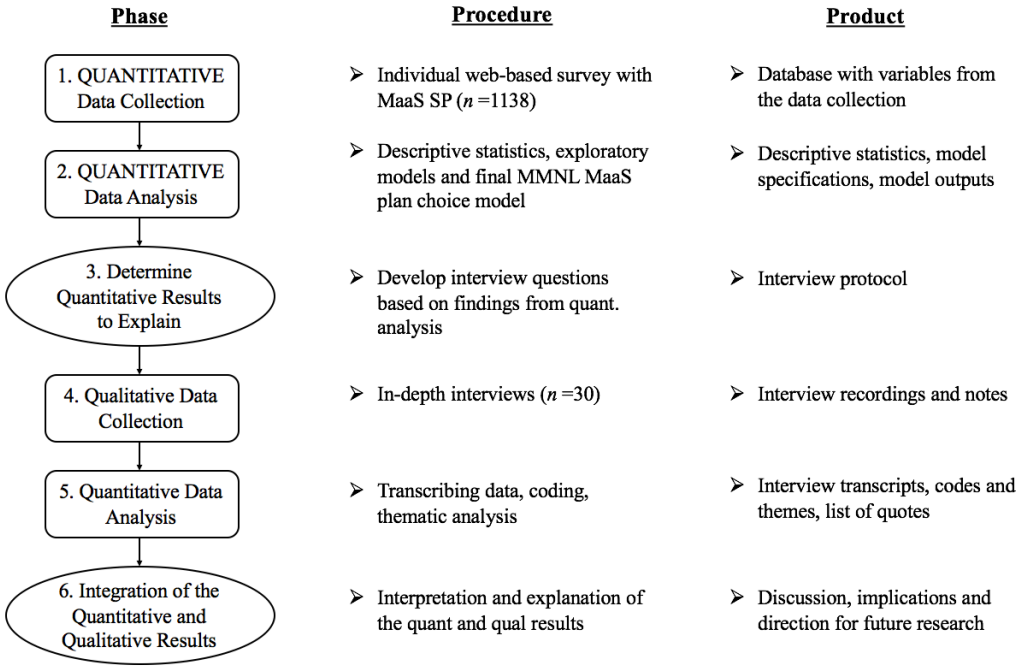


*Figure 1: Visual model of procedures for explanatory sequential mixed method design*

In the first, quantitative phase, a web-based survey is used to collect data from 1,138 individuals. The survey consists of a revealed preference (RP) section inquiring about the socioeconomic and current travel habits of the respondent and a stated preference (SP) experiment specifically designed to examine preferences for MaaS plans (details to be discussed below in section 3.2). It is important to note, that during the design of the survey, a small qualitative element was also carried out to evaluate respondents' understanding of the survey tool. In the second step, this data is analyzed using basic descriptive statistics and discrete choice models, namely mixed logit models. Using the findings from the quantitative results, elements that need further, in-depth exploration are identified in step 3. This is one of the points of inference for mixing. Interview questions are developed focusing on key topics that are uncovered in step 2 and the interview protocol is finalized (section 5.1). Next, qualitative data is collected through in-depth interviews with 30 people. Unfortunately, we do not have access to the sample used for the quantitative data collection, as such, a new sample is used. In step 5, the qualitative data is transcribed, and analyzed. Finally, step 6 integrates the quantitative and qualitative results and inferences are drawn about how the qualitative outcomes help explain the quantitative results.

### *3.2 Quantitative Survey Design and Data Collection*

The survey used in this study consists of a revealed preference (RP) section inquiring about the socioeconomic and current travel habits of the respondent and a stated preference (SP) experiment designed to examine preferences for MaaS plans (for more information about the survey design see: (Matyas & Kamargianni, 2017). Focusing on the MaaS SP, respondents were first presented with a description of the MaaS concept. The text was kept short, to the point and used familiar terms to aid comprehension and ensure that respondents actually read it. Next, 4 pages of hypothetical MaaS plans were presented, where the respondents were asked to choose their most preferred one. Each scenario has 4 alternatives: three fixed plans and one customizable / menu option where the users can determine which and how much of each mode they would like. These are presented alongside each other, but only one of them can be chosen. Thus, the outcome of a choice made from the options is either one of the three plans *or* any combination of the individual features in the menu option. An example of a scenario is presented in Figure 2. For the transport modes, icons were used with hover over explanations. Using pictorial representations makes users' perceptions of modes more homogenous, makes the task more interesting and easily understandable (Morikawa, 1989).

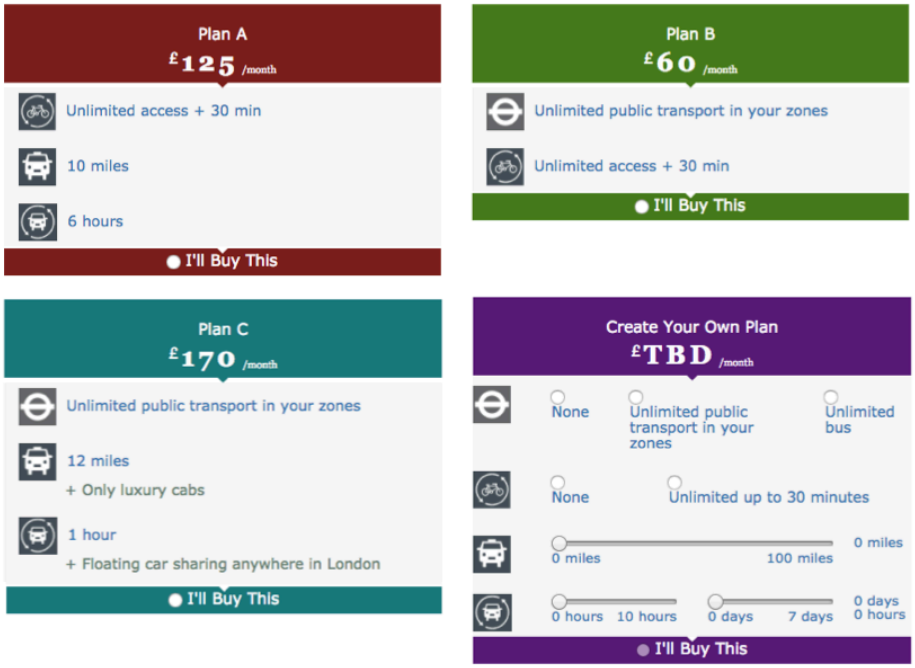


*Figure 2: Maas plans presented in SP experiment*

The core attributes in the plans are the transport modes: public transport (with two levels: unlimited bus, unlimited PT to match with the existing monthly pass options offered in London), bike sharing (yes, no), car sharing (with levels denominated in time), and taxi (with levels denominated in distance). Further attributes include the cost of the plan and additional special features such as 'transferability of unused travel to the next month' and '10-minute taxi guarantee'. The SP is context-dependent, meaning that the attributes and levels shown to each respondent are dependent on our prior knowledge about the individual. For example, if the respondent indicated in the RP element of the questionnaire that they have disabilities and are not able to cycle, the bike sharing option is not included in their plans. Further, a pivot design is used, whereby the SP levels are based on information from the travel habit questionnaire that precedes the SP.

Table 1: MaaS SP attributes and levels

| | Attribute levels for fixed plan | Attribute levels for menu |
|---|---|---|
| **Mode-specific attributes** | | |

| Modes | | |
|---|---|---|
| Public transport | Unlimited bus<br>Unlimited public transport in your zones | Unlimited bus<br>Unlimited public transport in your zones<br>None |
| Bike sharing | Unlimited access + 30 min use<br>None | Unlimited access + 30 min use None |
| Taxi | If *current taxi usage* >10 miles -><br>None, *current taxi usage**0.8, 1, 1.1, 1.3, 1.5 | 0-200 miles in increments of 2 miles |
| | If *current taxi usage* < 10 miles -><br>None, 5, 8, 10, 12, 15 miles | |
| Car sharing | If *current car sharing time* >0 -><br>None, *current car sharing time**0.8, 1, 1.1, 1.3, 1.5 | 0-20 hours in increments of 1 hours;<br>0-7 days in increments of 1 day |
| | If *current car sharing time* = 0 -><br>None, 1 hour, 2 hours, 4 hours, 6 hours<br>1 day, 2 days, 3 days + 2 hours | |
| Features | | |
| Bike sharing rental time up to 60 minutes at a time | Yes, No | NA |
| Floating car sharing anywhere in London | Yes, No | |
| Car sharing includes minivan access | Yes, No | |
| Can use any back to base car sharing company in London | Yes, No | |
| Pay for car sharing by the minute | Yes, No | |
| Add an additional driver to car club plan | Yes, No | |
| 10-minute cab guarantee | Yes, No | |
| Only luxury cabs | Yes, No | |
| Pooled taxi an option | Yes, No | |
| **Non-mode specific attributes** | | |
| Cost | (Sum of base prices) * 0.5, 0.6, 0.65, 0.75, 0.8, 0.9, 1, 1.1 | |
| Transferability | None of your credits can be transferred to the next month | NA |
| | All of your credits can be transferred to the next month | |
| Special Present | None | NA |
| | Free luxury car for a weekend | |
| | Free grocery delivery for a month | |
| | Free food delivery for a month | |
| | Free dinner for two | |
| | Free dinner for two (up to the value of £50) | |

The data collection was conducted in Greater London between November 2016 and April 2017. The survey was dubbed the London Mobility Survey (LMS). The sample used is that of 4,558 SP observations collected from 1,138 individuals. The characteristics of the sample are presented in Table 2, alongside the 2011 Census data and information available from the Greater London Authority (ONS, 2011; GLA, 2015). Regarding age, gender and income, LMS aligns fairly closely to the Census data. However, ethnic minorities are significantly underrepresented as are those without household vehicles. This, together with the limited sample size mean that the results of the study should not be generalized to the wider population of London.

Table 2: Characteristics of sample

| Variable | LMS N=1338 | Census /GLA N=3,266,173 |
|---|---|---|
| **Gender** | | |
| Male | 48% | 51% |
| Female | 52% | 49% |
| **Age** | | |
| 18-29 | 23% | 24% |
| 30-39 | 22% | 24% |
| 40-49 | 17% | 19% |
| 50- | 38% | 35% |
| **Ethnicity** | | |
| White | 83% | 60% |
| Black | 2% | 12% |
| Asian | 8% | 18% |
| Mixed /other | 7% | 9% |
| **Household Income** | | |
| Up to £19,999 | 20% | 22% |
| £20,000-£35,000 | 22% | 30% |
| £35,000-£50,000 | 17% | 21% |
| £50,000-£75,000 | 16% | 17% |
| £75,000-£99,000 | 9% | 6% |
| £100,000 or more | 7% | 4% |
| Prefer not to say | 9% | - |
| **Household vehicle** | | |
| Has household vehicle | 72% | 58% |
| Does not have household vehicle | 28% | 42% |

## 4 Quantitative Analysis and Results

### *4.1 Method of Analysis*

One of the complexities of model development using menu data, stems from the choice set. Taking into account all the possible combinations available to the respondent, the set of alternatives is over 26,000. Large choice sets arise from many decision contexts, such as residential location choice, trip destination choice, route choice, vehicle acquisition choice and departure time choice. There are three main strategies to navigate around such large choice sets: aggregation of alternatives, full sample enumeration and sampling of alternatives. Due to the relative ease of application, in this paper we opt to build aggregate categories of alternatives to greatly reduce dimensionality (Ben-Akiva & Lerman, 1982). This is especially useful when looking at choice sets where there are common characteristics in alternatives (e.g. Kim et al., 2003; Carod and Antolin, 2004; Pinjari et al., 2008). Also, as a result of the characteristics of our data, it is fairly straightforward to identify categories of alternatives. The alternatives from the menu are aggregated based on the types of modes included in them. As there are 4 modes, public transport, bike sharing, car sharing and taxi, hypothetically there would be $4^2$=16 possible combinations. However, the experiment constrained choices so that the respondent needed to choose at least 2 modes, and since some combinations were not chosen, only 10 categories remained. This, together with the three fixed plans resulted in a choice set of 13 alternatives. The resulting choice set in the following:

Table 3: Choice set details

| | | |
|---|---|---|
| 1 | planA | |
| 2 | planB | |
| 3 | planC | |
| 4 | $menu^{TC}$ | Taxi + Car Sharing |

| | | |
|---|---|---|
| 5 | $menu^{BT}$ | Bike Sharing + Taxi |
| 6 | $menu^{BTC}$ | Bike Sharing + Taxi + Car Sharing |
| 7 | $menu^{PC}$ | Public Transport + Car Sharing |
| 8 | $menu^{PT}$ | Public Transport + Taxi |
| 9 | $menu^{PTC}$ | Public Transport + Taxi + Car Sharing |
| 10 | $menu^{PB}$ | Public Transport + Bike Sharing |
| 11 | $menu^{PBC}$ | Public Transport + Bike Sharing + Car Sharing |
| 12 | $menu^{PBT}$ | Public Transport + Bike Sharing + Taxi |
| 13 | $menu^{PBTC}$ | Public Transport + Bike Sharing + Taxi + Car Sharing |

Turning to the model specification, with the aggregated choice set, the data is then used to develop discrete choice models belonging to the family of random utility models (Domencich & McFadden, 1975; Ortuzar & Willumsen, 2001). To start off, a base multinomial logit modal(MNL) is estimated. Due to its computational ease (closed-form mathematical structure), the significance of a large number of parameters can be tested. To include heterogeneity, systematic taste variations are included via interactions between the attributes of the MaaS plans and socioeconomic variables. Even though the MNL model is the workhorse of choice modelling, it rests on a number of important assumptions (Bhat, et al., 2016). As such, in the current application we turn to logit mixtures (mixed logit models, MMNL), which have a much more flexible structure (McFadden & Train, 2000, Walker et al., 2007). Most importantly for this study, mixed models are able to account for within respondent correlation across repeated choice observations (intra-respondent taste homogeneity) (Hess & Rose, 2007). By allowing tastes to be constant across replications for the same respondent, this panel effect can be accounted for, which is key factor when working with SP data. Further, MMNL models allow error components of different alternatives to be correlated, resulting in more desired structures (Blimer & Rose, 2010).

The model used in this study is a mixed logit model with error components specification, which captures inter-alternative correlation and panel effects. Since the random error is fixed, meaning that it does not vary according to the observed characteristic of the person or attributes of the alternative, the model is a normal error component logit mixture (NCLEM) (Walker et al., 2007). The error-components structure partitions the stochastic component additively into two parts: one that allows the unobserved error to be non-identical and non-independently across alternatives (correlated over alternatives and heteroskedastic) and the other part to be IID over alternatives and individuals (Gumbel distributed) (Bhat et al., 2016, Kamargianni, 2015). The former captures the correlation among alternatives (nested structure) and correlation across responses from the same individual (panel effect) and is distributed IID Normal (0,1) across individuals' *n* but remains constant within responses *t* from a given individual (Train, 2003; Walker et al., 2006).

In our model, the deterministic utility contains the attributes of the choice experiment and the socio-economic characteristics of the participants. Prior to modelling, the key factors that were hypothesized to affect utility were MaaS plan characteristics, individual socio-demographic characteristics and the individual's current mobility habits. A wide array of variables were tested including, but not limited to, age, gender, household income, education, employment, marital status, licenses, vehicle and bicycle ownership, awareness of shared modes, frequency of use of modes and travel pass ownership. The final choice of variables was determined based on data availability and estimation results (significance of t-tests of the estimated coefficients). Alternative specific constants were not estimated as the names of the plans (Plan A, Plan B etc.) do not carry any meaning. A number of other model structures (including nested logit, and models with additional error components) were also explored. The chosen MMNL model was selected on the basis of statistical goodness-of-fit (likelihood ratio test, significance of t-tests of the estimated coefficients, rho-square and adjusted rho-square).

### *4.2 Results*

This section presents and discusses the MMNL model estimation results. The model was estimated using the Pythonbiogeme v2.6 software (Bierlaire 2016). The number of draws was set to 500.

Table 4 provides the detailed results to the final model. The table is structured as follows: In section 1, those variables that entered the model via the fixed plans are presented. The socio-demographic characteristics of respondents displayed subsection 1.1 are used to investigate whether there are any significant differences in preferences for fixed plans versus menus based on the socio-demographic characteristics of respondents. As these variables were entered into all fixed plans and none of the menus, the menu in general provides the baseline for interpretation. Section 1.2 indicates respondents' preferences for each of the elements within fixed plans. Even though the SP experiment had three fixed plans presented to each respondent, the coefficients of each plan attribute are generic, as the plans themselves (plan A, plan B, plan C) do not carry any meaning. In section 1.3 systematic taste variations are shown through the interaction terms between the attributes of the fixed MaaS plans and socioeconomic variables. The last two sections of the fixed plans (1.4 and 1.5) are related to the additional features presented in fixed plans. Moving on to section 2, the variables presented in this part are those that entered the model via the flexible plans. Sub-section 2.1 are characteristics that entered into more than one of the flexible plan utility functions. Sections 2.2 - 2.11 present the coefficients for variables that are specific to each of the flexible MaaS plan alternatives. Finally, section 3 provides the error components of the model, that capture the correlation among the alternatives (nesting structure) and the correlation across responses from the same individual (panel effect). As the number of coefficients estimated in the model is quite extensive, in this paper we will only discuss selected ones. We encourage the interested reader to examine Table 4 for more information about the effect of the other factors that proved significant in the model.

In line with the research questions of this paper, we will focus on the modes and features that respondents favored or disliked in their plans and individual characteristics that proved to be important when choosing between MaaS plans.

Table 4: Model estimation results

| **Variable** | **Coef.** | **t-stat** |
|---|---|---|
| **1. Fixed Plans** | | |
| 1.1Socio-demographic characteristics specific to fixed plan utilities | | |
| Under 30 years of age (dummy) | 5.46 | 4.67 |
| In full employment (dummy) | 4.67 | 6.32 |
| Household income per member under £10,000 (dummy) | 1.68 | 2.09 |
| Under 30 interacted with full time employment | -5.49 | -3.52 |
| 1.2Fixed plan specific characteristics – cost and modes | | |
| Plan cost (scaled) | -0.20 | -4.44 |
| Travelcard (dummy) | 0.47 | 7.54 |
| Bus pass (dummy) | 0.62 | 8.83 |
| Bike sharing (dummy) | -0.38 | -6.01 |
| Car sharing (dummy) | -0.40 | -4.82 |
| Car sharing days (continuous) | -0.52 | -15.33 |
| Car sharing hours (continuous) | -0.03 | -3.14 |
| Taxi (continuous) | -0.06 | -12.15 |
| 1.3Fixed plan mode specific interaction terms | | |
| Under 30 (dummy) interacted with bike sharing (dummy) | 0.29 | 1.77 |
| Over 65 (dummy) interacted with bike sharing (dummy) | -0.25 | -1.95 |
| Bike sharing user (dummy) interacted with bike sharing (dummy) | 0.33 | 2.86 |
| Household owns bicycle (dummy) interacted with bike sharing (dummy) | 0.29 | 2.79 |
| Travelcard (dummy) interacted with travelcard ownership (dummy) | 0.32 | 2.92 |
| Frequent taxi user (dummy) interacted with taxi (continuous) | 0.05 | 5.05 |
| 1.4Additional features | | |

| | | |
|---|---|---|
| Additional feature(s) presented (dummy) | -0.22 | -4.17 |
| Floating car sharing included (dummy) | -0.16 | -1.71 |
| Any car sharing company can be used (dummy) | -0.38 | -2.80 |
| Car sharing can be paid by the minute (dummy) | -0.24 | -1.87 |
| Bike sharing up to 60 minutes (dummy) | -0.16 | -1.72 |
| Luxury taxis only (dummy) | -0.41 | -5.12 |
| 10-minute taxi guarantee (dummy) | -0.28 | -3.58 |
| Taxipool included (dummy) | -0.53 | -8.52 |
| 1.5Fixed plan additional feature interaction terms | | |
| Car sharing awareness (dummy) interacted with 'any car sharing company can be used' (dummy) | 0.35 | 1.97 |
| Under 30 (dummy) interacted with 'bike sharing up to 60 minutes' (dummy) | 0.29 | 1.77 |
| **2.Flexible plans** | | |
| 2.1 Generic variables | | |
| Plan cost | -1.26 | -7.12 |
| Retired (dummy) specific to those plans without public transport chosen | -3.13 | -4.85 |
| Household income under £25,000 (dummy) specific to those plans where public transport was chosen | -2.43 | -3.24 |
| Household has children (dummy) specific to those plans where public transport was chosen | -1.77 | -3.33 |
| Travelcard was chosen (dummy) specific to those plans where public transport was chosen | 8.68 | 12.79 |
| 'Taxi under 10 miles distance was chosen' (dummy) specific to those plans where taxi was chosen | 2.13 | 4.75 |
| 'Car sharing day and hour over 2 was chosen' (dummy) specific to those plans where car sharing was chosen | 14.90 | 9.69 |
| 2.2 Menu$^{TC}$ [Taxi + Car Sharing] specific variables | | |
| Household vehicle driver (dummy) | 3.21 | 6.10 |
| Bike sharing user (dummy) | -2.94 | -2.82 |
| Income per household member under £10,000 interacted with under 30 | 4.11 | 3.13 |
| 2.3 Menu$^{BT}$ [Bike Sharing + Taxi] specific variables | | |
| Full license owner (dummy) | -6.02 | -4.38 |
| 2.4 Menu$^{BTC}$ [Bike Sharing + Taxi + Car Sharing] specific variables | | |
| Full license owner (dummy) | -5.16 | -5.79 |
| Frequent taxi user (dummy) | 2.61 | 2.18 |
| 2.5 Menu$^{PC}$ [Public Transport + Car Sharing] specific variables | | |
| Full license owner interacted with under 30 | 3.62 | 2.57 |
| Full time employment (dummy) | -1.55 | -2.23 |
| 2.6 Menu$^{PT}$ [Public Transport + Taxi] specific variables | | |
| Female (dummy) | 2.00 | 4.43 |
| Retired (dummy) | 2.22 | 3.33 |
| Bike sharing user (dummy) | -2.48 | -2.76 |
| Frequent taxi user (dummy) | 2.91 | 3.07 |
| 2.7 Menu$^{PTC}$ [Public Transport + Taxi + Car Sharing] | | |
| Full employment (dummy) | -1.98 | -3.61 |
| Full license owner (dummy) | 2.04 | 4.23 |
| Bike sharing user (dummy) | -2.59 | -2.65 |
| Self-employed (dummy) | -3.31 | -2.62 |
| Household income per member over £40,000 (dummy) interacted with over 65 (dummy) | 2.62 | 2.55 |
| License owner (dummy) interacted with under 30 (dummy) | -3.96 | -4.30 |
| 2.8 Menu$^{PB}$ [Public Transport + Bike Sharing] | | |
| Full license owner (dummy) | -2.37 | -3.93 |
| Household child (dummy) | 2.49 | 2.60 |
| 2.9 Menu$^{PBC}$ [Public Transport + Bike Sharing + Car Sharing] | | |
| Female (dummy) | -4.81 | -3.22 |
| Full employment (dummy) | -6.08 | -4.60 |
| 2.10 Menu$^{PBT}$ [Public Transport + Bike Sharing + Taxi] | | |
| Full employment (dummy) | -2.57 | -3.65 |

| | | |
|---|---|---|
| Household vehicle driver (dummy) | -4.30 | -4.89 |
| Frequent Uber user (dummy) | 3.49 | 1.91 |
| 2.11 Menu$^{PBTC}$ [Public Transport + Bike Sharing + Taxi + Car Sharing] | | |
| Retired (dummy) | 3.47 | 3.75 |
| 3. Error component | | |
| SIGMA Fixed plans | 1.05 | 1.81 |
| SIGMA Menu – bike sharing | 5.26 | 9.89 |
| SIGMA Menu – car sharing | 3.84 | 7.81 |
| SIGMA Menu – public transport | -1.89 | -6.08 |
| SIGMA Menu - taxi | -5.07 | -8.30 |
| Sample size: 4558<br>Initial log likelihood: -6629.24<br>Final log likelihood: -4469.59<br>Rho square: 0.326 | | |

### 4.2.1 Evaluation of modes and features in MaaS plans

Examining the results pertinent to the research question regarding preferences for modes and features in the plans, we approach the two plan types independently. All the transport mode specific attributes are significant at the 99% level. Out of all the transport mode specific characteristics, only the coefficients for the public transport options are positive, all the others are negative. The public transport attribute took three levels: (1) none, (2) travelcard, which is the public transport seasonal pass of London and (3) bus pass. When either one of these are included in a fixed plan (please note, they are mutually exclusive), this plan is more preferred than those without any public transport options in them. These positive coefficients support the theory that public transport needs to be the backbone of MaaS systems as it is a core part of individuals' travel preferences. Looking at the other modes, bike sharing (binary; part of plan-not part of plan) is negative, which means that if this is included in the plan, people prefer it less. Car sharing entered the model via three variables, all taking negative coefficients in the model. First, a binary variable (part of plan-not part of plan) was included in the model to capture the overall preferences of individuals for this mode. In addition, two continuous variables for car sharing days and car sharing hours were also included. Their negative coefficients indicate that the more that is included of these modes in a fixed plan, the less utility people gain from them. Taxi was only entered as a continuous variable. A dummy variable was also tested, but this did not show statistical significance. The negative sign of the bike sharing-taxi-car sharing modes will be revisited in following sections.

The final element of the fixed plans are the additional features. Besides the features themselves, a dummy variable was also included in the model to examine respondents' overall preferences for features included in fixed plans. It is very clear, that respondents are less likely to choose MaaS plans that include any special features in them. There can be a number of reasons behind this. First, when one or more features are presented in the plan, it becomes more complex to comprehend, which can be a deterring factor for many people. Second, many of the features are most likely not attractive to the general population. An interesting insight is that the feature "transferability" (meaning that unused credit can be transferred over to next month) proved to be insignificant in the model (thus was excluded from the final model). To examine this further, interaction terms were included to determine whether there are any population groups who do prefer certain additional features. The model results show, that those who were previously aware of car sharing services (and are most likely familiar with their business models in London) are more likely to subscribe to a plan if it allows users to use any of the car clubs in the city.

Turning to the flexible plans we will resort to basic statistical analysis to identify the frequency of each mode chosen as well as the most popular mode combinations. Out of the 4558 choice situations, respondents chose the create your own option in 789 (17%) of the cases. Looking now only at those

cases where the 'create your own plan 'was chosen; 78% of the plans that were created included some form of public transport, 24% of plans included bike sharing, 83% included taxi, 51% included car sharing hour and 32% included car sharing day. Looking at the combinations chosen, the most popular one was public transport + taxi with 28%, taxi + car sharing (21%) and public transport + taxi + car sharing (20%) was not far behind. The two least popular combinations were bike sharing + taxi and bike sharing + taxi + car sharing.

### 4.2.2 Individual characteristics affecting MaaS plan choice

Overall, our hypothesis that MaaS plan characteristics, individual socio-demographic characteristics and the individual's current mobility habits affect utility was proven correct. However, when it comes to socio-demographic characteristics, only a few of the tested variables were statistically significant. When deciding between fixed vs flexible plans only age, income and employment proved to be statistically significant. The estimated model shows that individuals with annual household incomes under £10,000 are more likely to choose fixed plans over flexible ones compared to those with higher incomes. This finding may, at least partially, result from the fact that the menu plans were priced proportionally higher than the fixed plans (meaning that a fixed plan would either have the same or lower price than a menu where the individual chose the exact same modes). This shows, that individuals with low household incomes are not willing to pay more for the option to customize their plans, and would rather go with the less expensive, predetermined bundles, even if this means that it does not necessarily fit with their desires.

Similar, positive, coefficients can be seen for those who are under 30 years old as well as those in full time employment. Holding all else equal, those who are under 30 gain higher utility from choosing fixed plans compared to their older peers; while those in full time employment prefer fixed plans more than those in other employment statuses. This shows some interesting insights into the preference towards fixed products over customized ones. While allowing individuals to customize their products has frequently been used as a successful marketing technique (Da Silveira et al., 2001), researchers have raised certain caveats with such methods. The increasingly complex configurations have led to consumers becoming easily overwhelmed with choice and information. Referred to as 'consumer confusion', this phenomenon can negatively affect decision behavior (Matzler et al., 2007). The model results show, that younger generations and those in full time employment are more likely to be affected by the 'consumer confusion' and the additional cognitive load that results from the customizable option. Therefore, these population segments should be targeted with either fixed MaaS plans, or ones with only very simple customizable options.

When combining age and employment status through an interaction term, the negative coefficient indicates that people under 30 who are in full time employment, actually prefer fixed plans less than those under 30 year olds who are in other employment statuses. This also supports the fact that those with less disposable income, most likely including young adults without full time employment, prefer the relatively less expensive fixed plans.

The individual characteristics that prove important when deciding on specific MaaS plan can be broken down into two categories: socio-demographic characteristics and current mobility habits. With regards to socio-demographic characteristics, overall, age, gender, income, employment status and household composition were those characteristics that had a significant impact on choice. Age was a reoccurring socio-demographic characteristic that proved to be significant in both fixed and flexible plans. When looking at fixed plans, those under 30 prefer bike sharing in their fixed plans more than their older peers, while those over 65 prefer it less. Looking to the flexible plans, some examples where age is significant include: the choice of Taxi + Car sharing, where out of the respondents with lower household incomes those that are under 30 years old prefer this choice of plan more than their older piers; the choice of Public transport + Car sharing, where out of the respondents with driving licenses, those who are under 30 prefer to choose this plan combination more; and the choice of Public transport

+ Taxi + Car sharing, where out of those where the household income per member is over £40,000, those that are over 65 years old prefer this plan combination more than younger respondents. Employment status also appeared significant in more than one of the MaaS plans, especially with regards to flexible plan choices. For example, retired respondents were less likely to choose plans without public transport in them compare to those in other employment categories. Possible reasons for this are that retirees get free public transport in London, have more free time and can take the possible longer public transport route, can use public transport outside of rush hour when there is less congestion inside and outside of the vehicles. Another socio-demographic factor that relates to public transport is whether the household has children. Those respondents where there are dependent children in the household are less likely to choose plans where public transport is included compared to those that do not have children. As boarding and alighting from public transport can be a hassle with children, especially younger ones, this result does not come as a surprise.

Turing to current mobility habits, these proved important in a number of places. Looking at a couple of concrete examples, current travelcard ownership plays an important role when choosing whether a plan should include public transport or not in both fixed and flexible plan choices. In the fixed plans, when current travelcard ownership is interacted with travelcard, the coefficient is positive and significant implying that those who own travelcards now would prefer to have these in their fixed plans more than those who do not. Likewise, the same can be seen with the flexible option, those who own a travelcard will more likely chose to include public transport in their plans than those that do not. Public transport is not the only mode where current mobility behavior influences plan choice. Those who have previously used bike sharing prefer to have this mode in their fixed plans more than those have not used this mode. When it comes to creating your own plan, those respondents who have previously used bike sharing are significantly less likely to create mode combinations that do not have bike sharing in it (taxi + car sharing, public transport + taxi, public transport + taxi + car sharing). Likewise, frequent taxi users (where 'frequent' was defined as using taxi at least once a week) are more likely to choose fixed plans with taxi in them and create flexible plans with taxi in them (bike sharing + taxi + car sharing, public transport + taxi, public transport + bike sharing + taxi) than those who do not use taxi often. The sign and significance of these coefficients, show that the prior behavior of the user is important when choosing MaaS plans, and that the blanket 'not prefer certain modes' that was discussed in section 4.1.1 is not necessarily true. This also shows that the prior behavior of the user is very important when choosing MaaS plans and also shows habit persistence in preferences when it comes to choosing fixed MaaS plans. This does not come as a surprise though, as it has been widely studied that travel is a habitual behavior (Schlich and Axhausen 2003; Friedrichsmeier et al. 2013; Polydoropoulou et al. 2013).

## 5 Qualitative Phase

### *5.1 Data Collection and Analysis*

After the quantitative analysis, some key areas of interest were identified. As the quantitative survey restricted the question and answer frame (meaning that potentially critical information may not be captured) the qualitative phase was purposefully conducted without a strict structure. As such, a semi-structured discussion guide was created covering the selected areas, which were used during the interview. The questions included in the interview focused around three priority areas where in-depth qualitative insights could complement the findings from the quantitative models. The three areas are (1) General understanding of MaaS, (2) Evaluation criteria of MaaS plans, (3) Overall opinion of the concept. The discussion guide included one or two main questions and a number of follow-up prompts for each area to help navigate the interview. Participants were encouraged to provide their own reasons for their answers in their own words and if necessary were reminded that there is no right or wrong answer. Question prompts were used selectively depending on the flow of the discussion. As the focus of this paper is exploring preferences for MaaS plans, we will solely focus on the second priority area

in the following. The main question about this priority area and the prompts/follow-up questions are presented in Table 5.

Table 5: Semi-structured questions and prompts used in interview

| Priority area | Main question | Follow-up prompts |
|---|---|---|
| Evaluation criteria of MaaS plans | What was going through your mind when you were choosing between the presented MaaS plans? | • Most important factors you were looking for when considering the plans?<br>• Anything you were specifically looking for and why?<br>• Anything that specifically discouraged/deterred you from choosing certain plans and why?<br>• Specific modes?<br>• Additional features?<br>• Price vs mode tradeoff? |

We did not have access to the same respondents who completed the quantitative survey so a new sample had to be recruited. To recruit participants a mix of convenience and purposive sampling was used. Individuals were eligible if they lived within Greater London and were over 18. Participants with various socio-demographic characteristics (age, gender, family status, vehicle ownership) were chosen to ensure that different views were heard (see Table 6). It needs to be pointed out that the sample did not include anyone in the age group 65+, however, as this is not the primary target audience of MaaS, we believe this is not a major drawback at this stage. It should also be emphasized that the purpose of the qualitative research is not to gain a representative sample, but to illustrate important themes that may arise (and can be examined further in future research). 30 participants took part in the study and the interviews took place during June-July 2018. Each interview lasted between 45 and 75 minutes, depending on how long it took the participant to complete the survey and how interested they were during the interview. The interviews were audio-taped (with written consent from the participants) and transcribed.

Table 6: Characteristics of participants

| Characteristic | Group | Number of participants |
|---|---|---|
| Gender | Male<br>Female | 12<br>18 |
| Age | 18-25<br>26-45<br>45-65<br>65+ | 8<br>11<br>11<br>0 |
| Employment | Full time job<br>Part time job<br>Student<br>Other | 13<br>7<br>7<br>3 |
| Household composition | No children<br>Children | 14<br>16 |
| Household vehicle ownership | Yes<br>No | 20<br>10 |
| Household vehicle driver | Yes<br>No | 17<br>13 |

To start the examination, the transcripts were transferred into the NVivo qualitative data analysis software, through which a systematic approach could be taken to the analysis. Next, transcripts were closely scrutinized and pertinent excerpts were assigned a provisional conceptual code or codes (if the same text related to two or more separate codes). Codes are words, phrases or sentences that summarize interesting and relevant features of the data. They help organize your data into meaningful groups

(Braun & Clark, 2006). The codes were arranged hierarchically, with wide, general groups at the top and narrower sub-groups at the bottom. By systematically reading and rereading the transcripts semantic themes emerged, which were refined and cultivated throughout the process.

### *5.2 Results*

Before diving in, a few contextual points are worth mentioning. Travel habits and lifestyle contexts varied greatly within the sample. Some were devoted public transport users, who also exhibited multimodal travel involving cycling or taxis. Others were captive car users, who either for personal or geographical reasons commute mainly with private vehicles. From the discussion about the evaluation criteria of MaaS plans, some clear themes emerged, which are presented below. Quotations are provided to illustrate themes and related concepts and an identifier is used to indicate the characteristics of the respondent. The code represents their gender (Male or Female), age group (18-25, 26-45, 46-65) and vehicle use (Driver or Non-driver) respectively. The interviews provided a wealth of insights, however, in this paper we will focus only on selected elements that extend and supplement the findings from the quantitative analysis.

#### 5.2.1 Preference for public transport

The analysis confirmed that public transport is indeed a key factor in the preference towards specific MaaS plans. When discussing how participants evaluated between MaaS plans, the essential role of public transport was regularly mentioned. Almost all interview participants highlighted the critical role public transport plays in their regular daily travel behavior and how this would be the core element of their MaaS plans:

> *"I use public transport so much because I work in East London, but I live in West London. I'm always travelling to London and through London, so that is obviously something that I would be looking at straight away." F18-25D*

> *"I thought mostly about what it is that I use, so I thought cycling and public transport." F46-65N*

> *"I was deciding more on what I personally feel I would use - I would only really use bus travel and public transport." M18-25N*

The preference towards public transport in MaaS plans remained consistent regardless of whether the respondent was a car user or not. Even people who indicated strong dependence towards using their car for reasons such as having to carry their children to activities, the geographical distance of their workplace or their sheer love of using their car expressed that out of all the modes in the MaaS plans, public transport was the one that most interested them:

> *"If that was put into a package - unlimited public transport, then I would actually consider, should I get the tube up today?" F46-65D*

> *"If I still keep the commuting method, my private car, I could still use MaaS for all my private stuff - collecting daughter, weekend trips around, visiting friends and family and there I was really looking at the unlimited public transport and any of the other perks."M36-45D*

Another factor that illustrated the prominence of public transport is its relative importance compared to the other transport modes. Several participants commented on the fact that even when other modes were important, public transport was still the top priority:

> *"The specific modes I am looking for according to my current daily mobility pattern is unlimited public transport, that's the main one, then its taxi trips."M26-45N*

> *"The first thing I looked at was whether they had public transport and the second thing was whether they had the bike sharing because they are the two things that I use every day at least twice a day so they had to be in the plan really." M18-25N*

Finally, to solidify the idea that public transport should provide the backbone of MaaS (at least in the case of London), the analysis revealed that a number of people would not even consider plans without public transport in them:

> *"I would pretty much need unlimited travel on public transport network - so that one was the top one I was looking for and would generally avoid the plans without that." M26-45D*

> *"Yes, if it didn't have that [public transport] in the plan, I wouldn't use it at all."M18-25N*

This means, that even if other plans provided much more at a relatively cheaper price, most people would not consider those plans. All the other transport modes are frequently viewed more as supplements to public transport, rather than core elements of individuals' mobility portfolio.

### 5.2.2 Caveats to car share

The concept of car sharing, the role of car sharing in MaaS plans and the preference of respondents towards this mode were topics that were prominent in every interview. Most participants were keen to share their views on this mode without having to be prompted. Car sharing appeared to be a mode that a number of respondents did not want to have in their MaaS plans:

> *"The car share stuff, I couldn't really see myself using so I didn't really place any value on those." M18-25N*

> *"I saw car sharing and it was an obvious reject because I assumed it was more expensive." M26-45N*

> *"I don't think I'd do car share" F46-65D*

> *"I don't feel comfortable actually being the driver, so that eliminated any car shares. Car sharing and bike sharing I just didn't want them." F26-45N*

The example quotes highlight a theme that may provide an explanation to the negative coefficient sign of car sharing (and bike sharing and taxi) observed during the quantitative analysis. Through the discussion, it emerged that many people would directly reject plans that included modes they would not want, and would not even examine these. In these cases, disregarding any plans with these undesired modes meant that the choice set that respondents actually considered was smaller. As a result of the clear rejection of certain plans, in a number of cases people ended up selecting plans that cost more for relatively less mobility. This points to something that could be taken into account during future Maas plan modelling exercises; and that is the consideration choice set. There is body of literature aimed at exploring the impact of consideration effect on consumer choice (Ben-Akiva & Boccara, 1995; Basar & Bhat, 2004; Hauser, 2014), however it is out of the scope of this paper to delve into this in more detail.

Even though a number of respondents exhibited the choice behavior pattern described above, in many cases, respondents said that they would be interested in car sharing in theory, and they see how this could be a great approach to people decreasing their use and ownership of cars.

> *"I think I would try and buy a bike and then get rid of the car and buy a car share of a certain number of hours." M26-45D*

> *"The other two were a bit of an unknown because I don't use car share – although I think the car share idea is really brilliant. I do know of them, but I think they are something that we would use more if we were aware, or there was a discount or there was a chance to use it once a month and make the most of it." F46-65N*

A common theme that emerged through the analyzed texts is that much more people were interested in car sharing than actually picked it due to concerns regarding service quality and availability. Participants expressed a number of caveats that made them steer away from this choice now, but if

they were ensured about these, car sharing could in fact be an important part of their MaaS plans. Factors such as reliability, security, cleanliness, availability of child seats and location of vehicles were among those that were mentioned:

> *"Maybe if it was something that was available in the area and it was a definite that I could always access it, then I would definitely consider getting rid of my car and using a car share if it had the things that I need - if I knew that there was always going to be a baby seat in the trunk or something that I could use and then if it was close." F26-45D*

> *"The car sharing, since I've never used one, yes that's something I could consider, but it would have to have flexibility and speed of access and that it's not too far to walk to get one." M26-45N*

> *"As long as I knew it [car sharing vehicle] was reliable, safe, clean – definitely" F26-45D*

> *"The whole car share thing for me - I like the idea of it, but I wouldn't necessarily car share, because I have children and I would need to know that the car was clean and driven by a non-smoker - one of my daughters has asthma so if a smoker was using the car, I wouldn't be able to share with strangers." F26-45D*

### 5.2.3 Indifference to features

The analysis of the transcripts corroborated the negative coefficient signs in the model results for the additional features presented alongside the modes in the MaaS plans. As these additional features mainly showed up in more 'complex' plans which included more modes at an increased price, a number of respondents expressed that the increase in price alongside the disinterest of the features would drive them away from choosing those plans.

> *"They tended to be more expensive than I probably could see any reason to go for and knowing that they would also be features that I probably wouldn't be using." F46-65D*

> *"I think I noticed a couple of them, but they were nothing to draw me in on that sort of price per month." M26-45D*

> *"I did look at them, but then I did look at the price as well, so they did influence my decision, but they didn't influence me enough to warrant me selecting that option." M18-25N*

These additional features, that were linked to certain transport modes such as '10-minute taxi guarantee' or 'includes minivan access', did not play an important role in the evaluation of plans. Most participants did not even notice them as their main focus was on the modes and the price in the plans.

> *"I did see them. They wouldn't swing the decision for me." M18-25N*

> *"I noticed them, but they wouldn't probably weigh in." F46-65D*

> *"I didn't really notice them, I did notice the minivan one, but I didn't even notice the luxury cab one, so it didn't make any difference. I just focused so much on the unlimited public transport and the bikes that I didn't really pay attention to what's in the car sharing option." F26-45D*

## 6 Conclusions

To bring together some of the main results from the quantitative and qualitative phase; both the quantitative and qualitative results support the idea that public transport is a critical element of MaaS plans. The preference towards public transport remains consistent regardless of the socio-demographic characteristic or car ownership of the respondents. This was the mode that respondents looked for first, and would not consider plans without this. Regarding the other modes (bike sharing, car sharing, taxi), the quantitative results indicated that overall, people have a strong disfavor towards these as shown by the negative coefficient signs. Looking into the reason for this through the qualitative analysis, it

became clear that many people directly reject plans that include modes they would not want and not even examine these. This causes them to select plans that from a modelling perspective may not seem rational. Even though these negative views seem to indicate that plans overall may not make sense, both the quantitative and qualitative analysis provide some insights to the contrary. First, the quantitative results also show that people who currently use these modes are more likely to favor them in their plans due to habit persistence. Second, the quantitative analysis highlighted a theme, that many people would indeed be interested in certain modes other than public transport if certain level of service was guaranteed. Finally, both the quantitative and qualitative results indicated that individuals do not want mode specific additional features in their plans.

There are a couple of limitations of this work that need to be noted. Regarding the stated preference design, an efficient design should be used for future surveys as they provide the most reliable results. Also, we recommend allowing for a no choice option. With regards to the qualitative element, given the small sample, the limitations with regards to the external validity of the findings are acknowledged. Even with these limitations, this paper provides valuable insights to the research community, the public and private sector. As there is still much to learn about consumer demand and user preferences for MaaS, this paper can inspire further research in the area.

## 7 Acknowledgement

This research is supported by the RCUK Centre of Energy Epidemiology and the EPSRC. The authors of this paper would like to thank Sridhar Raman for assisting in the development of the survey tool.

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