SPREE Country Feasibility Study Report

Mobility Sector in the UK

Deliverable 7.1.4

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Executive Summary

The SPREE Country Feasibility Study is the key deliverable for Work Package 7 (WP7).

The objectives of WP7 are:

- To test the identified Servicizing systems\(^1\) and their impacts on achieving absolute decoupling and social benefits using three sector specific models with local country conditions;
- To assess the feasibility of pursuing Servicizing opportunities and anticipated policy outcomes for the different partner countries;
- To set the ground for the preparation of the more general Policy Packages using the insights from qualitative assessment, models simulations, and sensitivity analysis.

This report provides an up-to-date account of the research undertaken in the UK case study of the mobility sector of the SPREE project. The indicators and case definition are revisited, before the country-specific methodology is explained. Background and UK context is offered before subsequent changes to the approach which occurred during the process of developing the methodology and gathering the research are explained in depth. The primary, preliminary results are presented and discussed.

The case area selected for the UK study was London and the focus of the work was to consider the extent to which it is possible to move along the servicizing continuum from car ownership to more service-based mobility, concentrating on car- and bike-sharing. Environmental, economic and social indicators were developed to ascertain the extent to which servicizing in this sector can lead to a more resource efficient economy.

The research to investigate this area included expert interviews with relevant stakeholders, a focus group discussion with potential users and an online survey completed by a representative sample of the population of Greater London.

The data garnered in these activities was fed into the agent based model (ABM) which was produced to examine a variety of scenarios and whether, and/or the extent to which, the market for producing businesses and the behaviour of consuming individuals would be altered by the presence of car-sharing services in the market.

The preliminary results demonstrate that when there is less servicizing, there are more cars on the road, all measured environmental impacts are worse and the social impacts for particular social groups (low income women) are greater, which suggests that if there were

\(^{1}\) This report does not include the policy aspects of SPREE research in the Mobility sector. Policy measures to promote servicizing in the Mobility sector and their impact on absolute decoupling will be presented and discussed in length in the key outcome of SPREE project: “Servicizing Policy Packages”.

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to be more servicizing, certain negative impacts would also perhaps be lessened. In terms of social impacts, income was seen to be a more important driver of behaviour than age or gender. High income groups of both genders used services less than other consumer groups. The small luxurious car model was demonstrated to be the most popular vehicle for sharing across consumer groups.
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1. Background

1.1 Sector-specific indicators

In line with the SPREE methodology described in the Work Package (WP) 3 of project: “methodology”, the SPREE Mobility Research (SMR) in WP5 (“Case study of the Mobility sector”) began by identifying the indicators specific to servicizing in mobility. This required an extensive literature review of the existing indicators for decoupling in transport and of the social aspects and impacts of transport. Based on the mobility team’s expertise, the modelling requirements and the case definition of the SMR, these indicators have been altered to fit into the definition of servicizing in mobility. Here, we briefly summarise the indicators we identified in WP5:

Economic and environmental assessment: decoupling indicator

The decoupling indicator for the mobility sector in this project is identified as the emissions and/or energy use per unit of revenue and income from car club sector growth (or vehicle km driven if bike-sharing is the focus depending on the country system definition). This indicator was defined also as the overall objective of the future Mobility Servicizing Policy Packages. To the full list of economic and environmental indicators that we explored throughout the research, please see Deliverable 5.1: Mobility Sector Report.

Social impacts

The distribution of benefits and costs across consumer groups by age, gender, income, household size, mobility assets and with different instrumental values such as availability and convenience

The desired social impacts in terms of affordability, which should be the reduction of total household expenditure on travel to below 10% of income (zero for low-income households)

Accessibility can be measured by the change in journey times to employment, education, primary health care providers and social activities and living within a 15-minute ‘safe walk’ to designated parking spaces and docking stations.

Indirect impacts: Governance and political economic aspects can have four main indicators. In terms of employment with the impacts of moving from production-led growth to a service economy, it is ensured that the job losses and gains (and their distribution amongst social groups) are also accounted for as a result of moving away from the focus on car manufacturing toward selling mobility services. Equal access to decision-making is also subjectively identified by how citizens’ will to participate in local planning measures changes. Accountability of transport governance can be indicated by the transparency of pricing regimes and the deals between the service providers and local governments. Regarding integration, it is ensured that the cross-sector (dis)benefits (including impacts on education and health sectors) are also identified during the transitions toward car-sharing and bike-sharing.
Table 1: Summary of the indicators

<table>
<thead>
<tr>
<th>Decoupling pathway</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wellbeing from economic growth</td>
<td>Consumer groups according to age, gender, income, household size and mobility assets and habits</td>
</tr>
<tr>
<td></td>
<td>Affordability (cost of vehicle sharing relative to income)</td>
</tr>
<tr>
<td></td>
<td>Accessibility (journey times to employment, education, primary health care providers and social activities)</td>
</tr>
<tr>
<td></td>
<td>Indirect indicators: Employment impacts of moving from production-led growth to service economy; equal access to decision-making; accountability of transport governance</td>
</tr>
<tr>
<td></td>
<td>revenue and income/No. of cars; car mileage driven; total shared trip/total mileage driven; travel speed</td>
</tr>
<tr>
<td>Economic growth from transport shift</td>
<td>No. of cars; car mileage driven; total shared trip/total mileage driven/CO$_2$ emissions and air pollutants; fossil fuel use</td>
</tr>
</tbody>
</table>

Source: Del 5.1 (Akyelken et al., 2014)

1.2 Country research – case definition

The system chosen for study within the mobility sector considers the potential to move along the servicizing continuum between vehicle ownership, through the currently available methods of sharing to passenger transport in particular city contexts. The empirical work has focused on moving away from private car ownership towards servicized vehicle use mainly concentrating on car-sharing and bike-sharing.

In light of this broad SMR case definition, the emphasis of the UK case was on ‘moving along the continuum’ with specific focus on sharing of cars and bicycles. Due to problems with
data availability and modelling, we narrowed down our focus to formal back-to-base car-sharing schemes. In the ABM, we also included bike-sharing schemes and other types of car-sharing as part of the consumption models with a view to understand consumer behaviour amongst the options and to test these services as part of the market and policy scenario developments in other countries. The main products and services in the model are therefore cars (and bikes in some cases) and sharing services.

Due to the complex nature of vehicle sharing (mainly in terms of space-time and ownership), important actors emerged to consider when drawing the system boundary of the moving away from private car ownership through car- and bike-sharing systems. In the UK context, these included central and local governments; service users (individuals, firms); car-owners; non-car-owning user (driver/passenger); non-driving user; service provider; insurance and infrastructure provider; producer/manufacturer; employers and employees. Although the regulators are not included in the model, we paid close attention to regulation trends through qualitative research in the UK context.

Geographically, we decided that the system would be investigated at city-metropolitan scale mainly due to higher levels of usage of vehicle sharing in densely populated areas, but also the potential of replacing ownership by sharing in outer regions particularly in London. We initially focussed our attention to a large city and a medium-sized city, namely London and Bristol, to understand the implications of scale of a city for the uptake and the impacts of servicizing in mobility.

Based on this general description of the SMR case, the initial task included providing an ABM description of the UK case, which was done through expert interviews and desk-based research. The full definition of the SMR case is provided in the SPREE “Deliverable 5.2 Sector-Specific Agent Based Model Definition for the Mobility Sector”. Based on the initial research, we identified two critical aspects that should be considered in the ABM mobility case definition (Akyelken et al., 2014):

Consuming business groups are important in the UK case as the majority of the revenue of the London car clubs comes from large organisations like public bodies and universities. Although this necessitates the inclusion of consuming business groups in modelling, due to data collection constraints, we decided that ABM will not consider consumer business groups.

Given the small number of businesses in the sector in the country, we identify the service providers in units rather than groups. We only focus on back-to-base car clubs as the producing businesses.

With these initial descriptions in mind, together with the modelling team, we further specified the ABM definition. The ABM calibration processes revealed two important aspects.

First, the consideration of leasing by service providers proved to be difficult in the ABM configuration. The modelling team decided to include ‘leased car’ as a separate product in addition to a normal car product.
Second, the consumption bundles (i.e. combination of consumption models by mobility need) that we had initially wanted to test could not be modelled due to crude assumptions of the model. We therefore had to limit the definition of use of mobility to distance travelled (km) with a time unit of a week.

In addition to the changes made during the ABM process, it was decided to drop the London vs. Bristol distinction and for the modelling purposes to take into account the inputs from the London case alone. This choice was made following the Stated Preference analysis that has shown that the distinction between consumers from the two cities creates “over segmentation” that jeopardizes the significance of the results. As the overall group of surveyed consumers was divided to groups according to different parameters deriving from the survey’s responses (socio-economic status, age, gender, etc.), then creating another division according to cities yielded even smaller groups in number impeding the ability to identify correlations and significant outcomes. The Stated Preference analysis (described in the following section) has showed that other characteristics, such as socio-demographic attributes without differentiation between the two urban contexts, have been found significant in terms of the move towards servicing, while adding the differentiation eliminates the significant nature of results. Overall, although the focus of the UK model is on back-to-base car-sharing service, the team included other services such as EV sharing as part of the consumption models in case the other case studies’ teams (in Finland, Sweden, UK and Israel) want to test the relevant market and policy scenarios. The data provided has been changed by the modelling team for the models’ calibration purposes. Please see Appendix B for further details.

2. Mobility Sector – Specific Methodology

2.1 Behavioural Data

This section describes the consumer behaviour research methodology that was developed and deployed and how it is used in the ABM model in a later stage.

2.1.1 Preliminary understanding of consumer behaviour variables

In order to identify the generic variables that might affect consumers behaviour, our work has focused on four ground levels: First, a characterization of several basic variables related to consumer behaviour was drawn from the consumer behaviour literature. These variables were chosen based on their assumed relevance on the decision to switch to Servicizing.

Second, we conducted several interviews with marketing and consumer behaviour exports from the academia in Israel. The goal was to get opinions and insights about the variables that have been identified through the literature review, in addition to widening the list of variables related to consumer behaviour which might be involved in the decision to move to servicing.
Third, we conducted focus groups to better understand consumer motives and opinions toward Servicizing and to try identifying generic aspects that repeat, regardless of the specific Servicizing examples provided.

Fourth, the outcomes of the previous steps served us in the following step of the research – interviewing a wide range of marketing and consumer behaviour experts from the academia and industry and building specific tools for collecting empirical data in the field for the different SPREE case studies.

The generic consumers' variables are all summarized in the internal report of "task 2.7: Consumers" and are available by demand. These variables were deliberated among the partners and presented to the entire SPREE consortium in Workshop 3 in Helsinki (August 2013). The internal 2.7 report (including consumer side's aspects, as well as a thorough evaluation of the additional key components of servicizing: business models, innovation, ICT, complexity and infrastructure) served as the basis for the sector-specific research in the Water, Mobility and Agri-food sectors.

2.1.2 Structuring the questionnaire using the "Stated Preference" Approach

Based on the generic variables identified in the previous stage, a questionnaire was designed and tested. The questionnaire design was based on a Stated Preference (SP) choice-modelling framework. This framework is suitable to evaluate consumer preference towards a product or a service (hereinafter – "good"). The underlying economic theory is that the utility consumers derive from consuming a good is associated with the entire set of attributes that characterize the good. Hence, in the SP approach, a good is described by its attributes. Each attribute can have one or several levels that can be continuous (i.e. price), categorical (ordered or non-ordered) or dichotomies (i.e. local / non local supplier).

Using SP modelling enables us to analyze consumers' preferences and decision-making, including their willingness to pay (WTP) / or being compensated (WTA) for a unit change in each of the attributes that describe the good. In addition, SP modelling enables us to evaluate the demand side, consumer surplus, and to segment the consumers by their socio-demographic background, as well as combining socio-graphic variables and other attitudinal variables such as risk averse, environmental awareness, hedonism or any other variables that had better explain consumers' choices.

It is important to emphasize the differences between Revealed Preferences (RP) and SP. First the SP approach, unlike the RP approach, suits to situations where we examine good that has no market (i.e. lack of implicit prices, like landscape services), or a new good that the consumer has no knowledge on experience with. In the case of servicizing systems selected for SPREE research, for a substantial part of the interviewees, made choices are hypothetical in this sense, hence the relevance of the SP rather than the RP approach to the research. In addition, SP has several statistical benefits over RP, as it doesn't necessarily require a large sample due to the number of choice menus. However, there are also several disadvantages originated from the bias that is created by a hypothetical choice in which the consumer does
not need to make any real payment. Despite its disadvantages, SP is commonly used when examining consumer preferences towards subjects such as public goods, open spaces, etc.

SP is based on "Random Utility model" – an economic theory that is based on the assumption that when we are faced with a discrete choice among a set of alternatives, the consumer will choose the alternative that maximizes his/her utility, given budget constraint and preference (tastes) structure.

For this purpose, different "menus" (usually 4-8 menus) are being presented to the respondent; each menu contains several alternatives (usually 3 alternatives) that describe the good by the levels of its different attributes (the attributes chosen in this case were those obtained from the previous generic stage). Then, the consumer is asked to choose his/her preferred alternative (in some cases, the 'opt-out' option is being allowed, meaning that not choosing any of the given alternatives is optional). By doing so, we “let their choices speak for themselves”, instead of asking direct questions about the respondents’ preferences and their WTP, therefore receiving better quality and non-biased data from the respondents.

The method used building the choice menus was a "Efficient design" – an advanced method that enables using a smaller pool of respondents while extracting the respondents' choices / WTP for each of the main effects, evaluating interaction effects from different orders.

Designing the choice menus was made through NGENE program (Institute of Transport and Logistics Studies 2007) that was developed by Hensher, Rose, Bliemer and others in CenSoc centre for decision-making research in Sidney University.

At first, a pilot study was undertaken (based on an orthogonal design), to validate the design structure and the choice of the attribute and attribute levels, as well as obtaining the prior values that are required for designing an efficient design. Based on the analysis of the pilot results, the primary efficient choices design was created.

The final questionnaire results are analyzed in a mixed logit model (from the Latent Class models) that accounts for consumer preference heterogeneity.

### 2.1.3 Consumer Behaviour in the ABM model

In the SPREE agent-based model (ABM), both the behaviours of businesses and consumers are simulated in the context of a servizicing system, which revolves around a central need that can be provided with different Products and Services. Supplying businesses are modelled as Producing Business (PB) agents, purchasing businesses as Consuming Business (CB) agents, and individual consumers as Consumer agents. We use the term ‘consuming agents’ (CAS) to refer to the last two classes. Consumer agents have one big decision to make: the decision which of the Products or Services type to buy and consume that is currently available on the market. This is called the ‘strategic decision’ of the consuming agents. The strategic decision involves the adoption of the Consumption Model (CM) that corresponds with the Product or Service of choice, which represents the process of consuming the Product or Service to fulfil the central need. We will call the alternative CMs...
that the consuming agents can choose from the ‘options’ (The full account of the structure of the models, including sector-specific ontology, are presented in details in deliverables 4.2, 5.2, 6.2: "Agent Based Models in the Water, Mobility and Agri-food Sectors"). The decision making of consuming agents is conceptualised in the ABM in the following way. CAs have a certain functional need, e.g. 3 kilometres of transportation per day. When comparing different options, they will compare the total costs (Consumers) or total profits (CBs) of using the options over a specific return-on investment period. In addition, however, the CAs will also consider the ‘preference scores’ of the options, which stand for the qualitative, non-financial features of the products and services. Preference scores are in the range of 0 to 10. CAs will have a preference weight for each of the preferences defined for a certain case study (servicizing system), in the range of 0 to 5. By multiplying the normalised weights (to a total of 1) with the scores and summing up, a ‘total preference score’ is calculated for each of the options. The CAs will combine the total preference score with the calculated total costs (or profits for CBs) of an option by means of their willingness to pay for 1 point higher preference fit fraction. In a similar way, they also take their willingness to pay for loyalty and willingness to pay for laziness into account. This leads to a final score in the form of an adapted total cost or profit value for each of the options, and the CAs will choose and adopt the option with the lowest cost value or highest profit value. Furthermore, the CA may have minimum thresholds for preference scores, which can immediately rule out some of the available options. Also, Consumers may have a maximum threshold for total costs per unit of need. Finally, how often CAs reconsider alternative options is determined by the strategic reconsideration period, while the frequency of reconsidering alternative PB offers of the same option is determined by the tactical reconsideration period.

2.1.4 Fitting survey results into the ABM model

The following properties of consuming agents are used to describe their decision logic:

- Need
- Willingness to pay for 1 point higher preference fit
- Willingness to pay for keeping with the same supplier (loyalty)
- Willingness to pay for keeping the same CM (laziness)
- Preference weights
- Minimum preference score thresholds
- Maximum threshold for total costs (in case of Consumers)
- Return-on-investment-period
- Strategic reconsideration period
- Tactical reconsideration period

The above data constitute the ABM behavioural input data, which should thus be collected for each case study. This is done through consumer questionnaires. Data on the need and the time/period-related properties can be obtained through direct, stand-alone questions about these aspects. The choices data will mainly be obtained through the use of the Stated Preferences Method (SPM) within the questionnaire. With this method, alternative Product and Service offers are described in the questionnaire multiple times (each time with
different combinations and properties), and respondents have to indicate the offer they prefer. This information is then statistically analyzed to derive coefficients and then converted into the preference weight for each of the preference parameter to provide the relevant values for the behavioural input data needed for the model.

2.2 Environmental Data

This section explains how the LCA data was identified and how it relates to the ABM.

2.2.1 Overall Approach

In order to quantify the environmental impact of transition to Servicizing, we need to quantify first the environmental impact of products or services using Life Cycle Assessment (LCA), therefore a variety of data is required. In a typical LCA, most of the research is used to collect data. LCA requires both knowledge of the entire lifecycle of the product – from raw material through the production process, the usage, to end of life – as well as detailed information of all the inputs that are used throughout the lifecycle.

LCA results are the quantification of environmental impact categories. The impact may be quantified as a set of environmental impacts ('mid-points') or as a set of damages ('end-point'). Mid-point categories include resource use, global warming potential, acidification, eutrophication and ecotoxicity. End-points may include for example human health or ecosystem quality. The list of mid-points and end-point categories and the calculation method depends on which lifecycle impact assessment (LCIA) method is used, e.g. ReCiPe, Eco-indicator 99, USEtox, Impact World+.

In the SPREE project, the ReCiPe method was used, and the impacts were quantified using mid-point categories. Not all impact categories were quantified in all cases. The relevant impact categories for each sector were selected based on a literature review for each case. In the review, common categories were screened in each topic. Impact categories, which were reported as significant in papers where normalization was performed, were also identified.

For each LCA case study, the process commenced with the definition of a flow diagram based on the case definition and description. An important part of this stage is defining the system boundaries - a trade-off between data availability (or the effort to collect it) and accuracy. In the SPREE project, the flows were divided into the ABM sections: tools, consumables, and service. A special attention was given to these definitions in order not to accidently double counting and to avoid missing processes.

After the flow diagram is prepared, data regarding the inputs to and from the environment at the different stages is collected. In the SPREE project data was mainly collected through existing literature, but typically data can also be collected through primary research.

The next phase is modelling. Each part of the flow was modelled using existing LCA-processes in the LCA software "GaBi". The outputs from the model, the list of environmental impacts per functional unit, were used as inputs to the ABM model. Overall, each service or
product was “tagged” with LCA data so when calculating the total impact of the system, data can be aggregated based on the different products and services that were chosen to be consumed.

The LCA data for the London case is detailed in Appendix A.

2.2.2 Case Specifics

In the Mobility case, the tools were selected as the car models in the car clubs in the different location, as well as bikes. Their impact included the impact of manufacturing and their end-of-life. The consumables are petrol-low sulphur, oil for bikes, and electricity for electric cars. Their impact includes their production and transportation to storage. The service was defined as km per passenger of leasing of different tools. The service impact includes the use of the car (in the case of bikes there is no impact of use them), and the impacts of roads and cars maintenance. Impacts were assumed the same for leased cars and normal cars.

2.3 Business Data

This section explains how the business data was identified and how it relates to the ABM

2.3.1 General Description of Data collection

Data collection was conducted through desk research, Semi-structured interviews with businesses, interviews with policy experts, industry experts, expert meetings and surveys. It included the following items: level of servicizing in the business in order to understand whether servicizing the only offer or offered jointly with other product based offers, cost structure, servicized offer characteristics, type of contract in the offer, required organizational and cultural adjustments or parameters linked to the servicized offer (for example impact on sales persons training etc.), differentiation of servicized offer, customer segmentation, strategic fit and added value as perceived by businesses, barriers and opportunities for adoption and market structure. Data collection differed in the case of the transport sector, where sharing schemes already existed and the water and agri-food sectors, where the servicized offer under consideration existed partially or did not exist at all and had to be extrapolate.

2.3.2 Sector Specific Descriptions

The data collection in the three sectors is described below, outlining specifics for each one.

Data collection included available car-sharing and bike-sharing schemes as well as additional complementary travel options which support the shift away from private car ownership. Car-sharing and bicycle sharing offers already exist in UK, therefore data collection was done through desktop research regarding servicized offers and through interviews and expert meeting with different stakeholders (see elaborated account in Deliverable 5.1: "Mobility Sector Report").
Semi-structured interviews were conducted with the following industry and policy experts: car clubs, different car-sharing and bike-sharing experts, parking association policy expert and city transport expert to collect information and data on: market structure, size of company, customer segmentation, business drivers, cost structure of the different offers and current support schemes, the role of ICT in servicized models of car-sharing and bicycle sharing, level of strategic fit of various parameters, differentiation of the offer from other mobility alternatives, barriers and opportunities for adoption and future market prospects for growth. The private-institutional nexus was examined to determine the role of government in car-sharing and bike-sharing schemes.

2.3.3 Business Behaviour in the ABM

The business input data used in the ABM largely consist of the same behavioural data as required for the consuming agents, explained in section 1C. This is because the strategic decision of Producing Businesses (PBs) concerns the evaluation of alternative ‘business models’ (combinations of one Manufacturing Model (MM) with a certain capacity, maximally one product-based Sales Model, and maximally one service-based Sales Model), on the basis of both total profits and preference scores. Therewith, the strategic decision that PBs take is similar to the strategic decision the CAs take. There are differences, however.

First of all, the PBs do not have a willingness to pay for loyalty and laziness, no maximum threshold for total costs, and no need. Secondly, they have three additional behavioural properties. The capacity over expected sales ratio determines to what extent the PB over-dimensions the production capacity of the MM, to cater for unanticipated demand growth. The risk aversion factor in market research determines the degree to which the estimated demand is discounted on. A high factor makes the PB less likely to switch to a servicizing business model, which can represent a high degree of prudence in following up on estimated demand and risking a failure to recover investment costs of a business model switch. The fraction of consuming agents asked in market research is exactly what the name suggests. A fraction of 0.25 means that a PB will target 25% of the CAs in her market research activity (in the market research, CAs express at which price they are willing to buy a certain new offer from the PB, which the PB uses to calculate a maximum expected profit for each of the strategic options). Finally, the tactical reconsideration period of the PB concerns the frequency of resetting the offer price(s) of the offered Product and/or Service, also based on market research.

2.3.4. How the Business Data is used in the ABM

The following properties of Producing Businesses are used to describe their decision logic:

- Willingness to ‘sacrifice profit’ for 1 point higher preference fit
- Preference weights
- Minimum preference score thresholds
- Return-on-investment-period
- Strategic reconsideration period
- Tactical reconsideration period
• Capacity over expected sales ratio
• Risk aversion factor in market research
• Fraction of CAs asked in market research

These data is obtained through business interviews, which reveals in an indirect way, e.g. to what extent businesses consider the properties of offered products/services next to profit maximisation (as part of a certain business strategy), on the basis of which the willingness to pay fraction will be set.

Other business data include the costs of production facilities, fixed and variable costs of production and product/service delivery, and purchasing prices. All costs related to the production or purchasing process of a certain base product (which is either turned into a product or service offer) can be entered in the cost-related properties of the Manufacturing Model. All costs related to the delivery of products and services to customers can be entered in the cost-related properties of the Sales Model. Purchase prices of products that are purchased by the businesses are located in the main property of the World Market. Typical (current) business model choices, production capacity values and offer prices are only used to initialise the business models and offers of the Producing Businesses in the model (as these are the result of the agents’ decisions in the simulation), and for validation purposes.

3. Country-Specific Methodology

The overall approach of the SMR included three steps; (1) conceptualisation, (2) potential of adoptability, (3) potential of impacts. Because the UK case was employed in the SPREE project as the guiding case for the three other countries’ case studies (Finland, Sweden and Israel), the first two research objectives were previously completed as part of Deliverable 5.1: “Mobility Sector Report”. As part of the conceptualisation in Del 5.1, we started by tabulation of the main aspects of the existing practices including infrastructure, Information Communication Technologies (ICT), eco-innovation and complexity issues through expert discussions and desk-research; the conceptual framework of social aspects of servisizing in mobility through desk research and restructuring of the practices into traditional transport modes and the identification of additional aspects including ownership and space/time analytics (Akyelken, et al, 2014).

We presented the set of guidelines for identifying the potential of adoption in the SPREE countries with applying to the UK case in Del 5.1. The potential of adoption of servisizing identified the causal mapping by pointing out the institutional and social settings of the medium-sized and large cities selected for adopting servisizing systems. This was done through desk-research, expert group discussions and expert interviews. The questions we tackled as part of the research concerned the availability, barriers and the uptake of servisizing in mobility. 13 semi-structured interviews were conducted during September–November 2013 in London and in Bristol. The participants in this study were academic, policy and industry experts (Appendix F). The table in Appendix C illustrates the interview guidelines followed for the UK case. In the following section, we briefly summarise the
findings of the research into the potential of adoption in the UK that we previously discussed in Del 5.1 (Akyelken, et al, 2014).

The final and the ultimate output of the UK SMR is to identify the potential of impacts of the servicizing system in the chosen cities that will provide further specification for measuring the impacts of servicizing. The research questions we previously tackled as part of this research objective concerned both the methodologies and conceptualisation in Del 5.1. Although the expert interviews were also employed to answer these questions, this research objective mainly employed the ABM modelling of the data we collected through business interviews. Some indicators were also explored through the focus group discussion (See Appendix D). The survey was prepared and designed by the TAU team.

The below table summarises the initial work plan agreed as part of the SMR and how it has changed throughout the research to reach the indicators we have selected.

Table 2: Summary of the indicators

<table>
<thead>
<tr>
<th>Decoupling and Social Impacts</th>
<th>Indicators and Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social impacts</td>
<td>Consumer groups according to age, gender, income, household size and mobility assets and habits</td>
</tr>
<tr>
<td></td>
<td>Affordability (cost of vehicle sharing relative to income)</td>
</tr>
<tr>
<td></td>
<td>Accessibility (journey times to employment, education, primary health care providers and social activities)</td>
</tr>
<tr>
<td></td>
<td>Indirect indicators: Employment impacts of moving from production-led growth to service economy; equal access to decision-making; accountability of transport governance</td>
</tr>
</tbody>
</table>

Methodology:

Indicator (1) is provided by the ABM based on the survey (see the table of consumer groups based on London data in Appendix E—it was decided to leave out the Bristol data. This choice was made following the Stated Preference analysis that has shown that the distinction between consumers from the two cites creates “over segmentation” that jeopardizes the significance of the results. As the overall group of surveyed consumers was divided to groups according to different parameters deriving from the survey’s responses (socio-economic status, ago, gender, etc.), then creating another division according to cities yielded even smaller groups in number impeding the ability to identify correlations and significant outcomes. Moreover, although the consumer expenditure by consumer groups provides insights into economic distributional impacts, the
Environmental impacts by consumer groups are interpreted differently with the ABM results. Indicator (2) is also discussed in the context of consumer expenditure and changing service prices over the simulation. Indicator (3) was planned to be captured by the consumer groups (by post-code) and the qualitative research. However, since the ABM model was already very complex, it was not designed to be spatial, therefore, relating to the zip code was not relevant for modelling purposes since there was no way to capture this in the model (this could be a nice extension of the model in the future). Furthermore, there were not enough data points for each zip code for doing meaningful statistical analysis. Indicator (4) including equal access to decision-making; accountability of transport governance were obtained through qualitative research conducted by OXF – see the Results section.

<table>
<thead>
<tr>
<th>Decoupling impacts Mobility from environmental impacts</th>
<th>No. of cars OR car mileage driven/CO₂ emissions and air pollutants AND fossil fuel use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methodology: The data we provided (See Appendix B) has been used by the ABM. The model provided insights into our decoupling indicator as explained in the Results section.</td>
<td></td>
</tr>
</tbody>
</table>

### 4. Background information on the selected cases

Given that Bristol data was not accounted for in the ABM, we have chosen to focus our attention to a large city primarily, London in the UK case. It should be noted that London has peculiar characteristics such as the congestion charging and extreme concentration of wealth, which should be considered later in the policy packaging process. This section reports the first set of results on the cases with a view to understand the potential of adoption of car- and bike-sharing primarily in London. In the UK context, traditional forms of car-sharing practices as known in the North America are called ‘car clubs’ while the bike-sharing schemes are called cycle hire schemes (Kennedy, 2013). Given that the main focus of the UK SMR is the back-to-base car clubs, it is important to start by providing an overview of the London car club sector.

London is one of the largest European back-to-base car club markets and car clubs play a major role in the strategy plan of the Transport for London (TfL), which is the chief institution responsible for transport in Greater London since 2000. The TfL provides
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guidance and funding for Local Implementation Plans (LIP) and supports the car club accreditation programme run by Carplus (see Figure 1). The car clubs were introduced to the agenda of TfL in 2003 in an effort to move away from private car ownership in the city and hence reduce fossil fuel consumption. From the TfL’s perspective, the presumed benefits of car clubs are congestion and parking space relief, taking cars off the road, cleaner fleets and reduced air pollution (Kennedy, 2013). Currently, the role of the TfL is limited to advising and funding the 33 London Boroughs and the provision of guidance for car club operators. The TfL’s 2008 Car Club Strategy is a key document in the framework provided for the car clubs in London. Other key actors involved in the car club sector in London are the car club operators, the London Councils, London Boroughs, Greater London Authority and Carplus, which acts as a national accreditation body for car clubs in the UK.

Initiated by City Car Club in 2000, the number of operators in the London market went up to four with the entrance of the US-based Zipcar in 2006. As of 2013, there are 2,231 car club vehicles and 131,000 members in London. 82% of the car club members in the UK live in London and 46% of Londoners are within a 5-minute walk of a car club vehicle (Kennedy, 2013). The former went down to 80% in 2014. The 2013/2014 Carplus survey suggested that almost half of the car club members in London comprise of professionals employed in creative industries and living in inner London areas, well-educated young professionals and very wealthy ambitious individuals living in most prestigious parts of the capital. The market is male dominated. These trends already suggest there are social exclusion aspects with respect to car clubs as already outlined in the previous steps of the SMR. With respect to ownership, according to the same survey, 80% of the respondents do not own a car. Finally, the car club fleet in London meet or exceed the current air quality standards (Euro 5) and the operators in London started to include electric vehicles in their fleets.

Overall, the London car club sector is a mixed market with significant role played by the local governments. Despite London being the largest car club market in Europe, the market is still a niche market, in which there are important players emerging both from the government and businesses.
The targeted population of bike-sharing is different to other mode-shifting policies. As with other bike-sharing schemes in the world, the desired goal of the London scheme is to introduce non-cyclists to cycling without having adverse impacts on the existing cyclists. It was introduced in 2010. The scheme provides 24-hour bike access and costs £2 for daily access and after the initial payment, the first 30 minutes of use are provided free. As of 2012, only 17% of the scheme members bought bikes as a result of becoming a member, while 70% of the members already owned bikes (Burr, 2013). As discussed in Del 5.1, the interviews revealed that while the bike-sharing scheme’s impact on non-cyclists is important for realising the benefits from the schemes, the assessment should put equal emphasis on the potential uptake of the schemes by institutions. The TfL data provided for the years between 2010 and 2013 show that the people living close to docking stations show the highest level of usage as expected and that the scheme is most popular amongst long distance commuters (Goodman and Cheshire, 2014). Moreover, amongst the registered users, women are less likely to use the scheme for commuting (Beecham and Wood, 2014). In fact, the percentage of trips made by women remained low, i.e. around 16-19% during this period (Goodman and Cheshire, 2014) and remained mainly as leisure trips.

Combined together with the initial insights from the SMR (Akyelken, et al., 2014) and recent developments, our research shows that there are three overall key trends in the vehicle sharing sector in the UK that are relevant to the SPREE project aim of decoupling through servicizing.

First and foremost, we can conclude that the car club sector in the UK is consumer-driven. While the earlier years of the market included small start-ups, the UK car club market has started to include car manufacturers and car rental companies. This shows that providing
car-sharing services does not replace the production of cars. In fact, as the business interviews revealed, the cars used for car-sharing services are usually employed for reasons of test-drives for new car products. The relevance of car clubs to the goal of decoupling then becomes its role in inducing behavioural changes amongst transport users. This is an important insight into the EU strategy for decoupling in transport as the current decoupling agenda includes car-sharing only as part of a broader mobility management system without looking into the details of the scheme.

Second, the governance implications of the initial insights into London and Bristol are of crucial importance for the purposes of the SPREE project. In both London and Bristol, the local government bodies including TfL and Bristol City Council are very supportive of car clubs in terms of both integrating them into public transport and providing necessary guidance for businesses. However, the peculiar nature of the governance system in London reveals the crucial role of parking in a car-sharing scheme. Mobility is a dynamic system, in which there is a constant circulation of mobility goods and people. The provision of parking permits is at the heart of the business model, given the high parking costs and congestion charges that come with private car ownership. A service provider usually has to negotiate with 33 different London Boroughs with respect to parking. In a flexible scheme, this becomes a more significant challenge; as such schemes need more flexible parking spaces. In fact, a floating car-sharing scheme had to stop its operations in London earlier this year due to different parking requirements of the London Boroughs.

This constraint also applies to the case of bike-sharing. Designated parking spaces can only be obtained through TfL providing funding for the London boroughs. In Bristol, provision of cycling infrastructure is seen a priority, though ownership is currently the dominant model due to the lack of a city-wide scheme. In Bristol, the political leadership also seemed to play a bigger role. All interviews in Bristol indicated the new mayor as a strong advocate for sustainable transport – cycling and car clubs look set to improve during his time in office. The differences in the successes in setting up a bike-sharing scheme in London and in Bristol are worth noting. In Bristol bike-sharing was tried and failed, primarily due poor location choice for infrastructure installation, the council remains positive about getting the new proposed scheme right. In London, too, Barclays has decided not to continue the sponsorship. Although this has recently been replaced by a new sponsor, such change of the scheme has implications for the perceptions of the public on the scheme.

Overall, London remains a special case in both car-sharing and bike-sharing. The peculiar governance system has created crucial challenges for both schemes and the existing policies such as congestion charging and the demographics should be carefully considered when drawing lessons from the London case.

5. Results

5.1 ABM Results and Decoupling indicators

5.1.1 Considerations
In the first step of the SMR, we have identified that the impact of servicizing in the mobility case cannot be evaluated in terms of the implications of the move from production to servicizing, given the current market conditions and the trends. As it currently stands, it is not possible to consider substitution of car production by car-sharing services; it is a consumer-driven economy and the decoupling indicator defined in the project can only change as a result of the changes in consumer behaviour given their preferences and what is available in the market. Furthermore, when interpreting the results of the ABM simulation, the limitations of the model and the process should be considered as well as the case definition. It was not possible to account for all the characteristics of the UK case definition. The basic assumptions and the definition of model are as follows. The PBs can only offer car-sharing or bike-sharing services and they cannot sell cars or bikes. Consumers can also choose to buy a car as a product (not from PBs), but cannot choose to buy a bike. The PBs’ strategic reconsideration time has been set at ‘25’, so that PBs will consider switching when the simulated period is 100 weeks. There are three PB agents in the base case, and one PB group. Initial Services offered by the PBs are ‘small economic car-sharing’, ‘small luxurious car-sharing’, and ‘medium economic car-sharing’. The reasons for why the full results cannot be interpreted are explained in the conclusion. The key terms in the definition of decoupling in the mobility sector are indicated in the ABM as follows.

- Household income = consumer expenditure
- Revenue = Revenue of PB groups
- Number of cars = car mileage driven does not change in the model
- Environmental impact = changes in the use of resources

5.1.2 General decoupling indicator: revenue, income and number of cars

When tested in the ABM, the decoupling indicator (emissions and/or energy use per unit of revenue and income from car club sector growth) demonstrated that with less servicizing, economic growth also experienced a decrease. But importantly, with less servicizing, all environmental impacts were higher (Figure 5). While the sectoral economic growth also declines, because it does not account for the revenue from producing cars, it may be misleading to conclude that economic growth declines with less servicizing.

<table>
<thead>
<tr>
<th>Economic/Environmental indicators</th>
<th>Observed ABM changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producing business revenue</td>
<td>Initial increase in profit for all producing businesses, before stabilising at just over £2,500 profit</td>
</tr>
<tr>
<td>Number of cars</td>
<td>Small luxurious cars make up 91% of use across all consumer groups (except mid-income young</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>Number of service units used</td>
<td>Small economical cars largest kilometres driven across all shared modes - mainly from mid-income young men</td>
</tr>
<tr>
<td>Environmental impact</td>
<td>All environmental impacts increased over the time sequence, as the level of servicizing decreased.</td>
</tr>
</tbody>
</table>

However, the consumer income (indicated by expenditure) and revenue of the producing businesses is negative with lower levels of servicizing. At the same time, the average price of sharing is increasing, which results in a lower market share for car-sharing in the world market. Therefore, in terms of changes that could be made to the model, a reduction in cost for the producing businesses and price changes for the service, may lead to an increased share of servicizing. Perhaps paying for services on a per-km basis, as opposed to a time-based charge, would also initiate further changes.

**Figure 5.** Servicizing rate, GDP and selected environmental impacts over time from SPREE ABM simulation
In terms of the broader environmental impacts, all measured units increased in the ABM. This demonstrates a need for vehicle and fuel types to be considered as part of a sharing business model as switching to alternatively-fuelled vehicles would perhaps facilitate the decoupling of some of these broader impacts more than simply switching to conventionally-fuelled shared vehicle fleets has demonstrated. Similarly, choice of vehicle model and also size of vehicle are important considerations. Looking at the number of tools units used over the simulation, we can observe that small cars including both luxurious and economic cars and medium and large luxurious cars are the most used cars. With the increase in the prices of the sharing services, the market share of servicizing is declining and car ownership is increasing. The inclination towards using luxurious cars of all sizes seems to be contributing to the environmental impacts.

The price of 3 particular models of car rose in the model over time. Small luxurious cars saw the largest change in service price over time but reached the point of £1.50 per km and stabilised. The small economic car and the medium economic car also experienced an increase in service cost overtime but in the case of the former, it too stabilised fairly soon into the run of the model.

Looking at the simulation results, as already predicted by the initial research, ownership for certain car products plays a key role. The model shows that overall demand for servicizing is decreasing, which denotes that there is no substitution of car ownership occurring in the model. This is particularly illustrated through the case of small luxurious vehicles. The sharing demand for this category of vehicle was decreasing, but ownership for the same size and type was increasing, demonstrating the social appetite for ownership remains strong in this context.

Other measures which could potentially affect the extent to which sharing has a greater impact on the indicators would be by examining the total number of cars of any given
business or in any given category, as well as an understanding of the total kilometres
travelled and frequency of use for any given vehicle (per trip and in total). However, because
the car mileage driven does not change in the model, our understanding remains limited to
categories of car types as explained previously.

According to the latest data available from the CarPlus 2013-4 survey, in London in 2013/14,
the average carbon emissions of car club fleets are 33% lower than the national average car
and 17% lower than the car club fleet average reported in 2011 (CarPlus, 2014). Moreover,
car club households travel 57% fewer miles by car compared to the London average. So the
environmental trends identified in the ABM analysis are generally supported by real world
findings.

5.2 Social aspects and impacts

5.2.1 Direct social impacts from the ABM simulation

It was clear that the income can be seen as a more important factor in the model than age
or gender. All individuals in each of the consumer profiles experienced a growth in income;
however, low income old women by far saw the lowest growth, with high income old
women seeing the highest range/diversity in cash balance. Age did not seem to have any
recognisable impact over the social impacts that were considered in the ABM. On the
individual level, it was also demonstrated that low income women were a social group
shown to be particularly disadvantaged in the model.

Table 5: Observed changes to social indicators over time from SPREE ABM simulation

<table>
<thead>
<tr>
<th>Social indicators</th>
<th>Observed ABM changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer groups</td>
<td>The lifestyle fit of both low income old men and mid income young men improved, all other consumer groups remained constant</td>
</tr>
<tr>
<td>Affordability</td>
<td>Low income old women largest fluctuation in expenditure</td>
</tr>
</tbody>
</table>

In terms of lifestyle fit, there was interesting diversity between age, gender and income.
Both low and high income men, as well as high income women experienced a high lifestyle
fit in the model. Low income women were the group with the lowest lifestyle fit score, and
mid-income young men were also somewhat lower than the other economic groupings of
men. Mid income young women experienced a similar level of life style fit with high income
old men – which is interesting.

In terms of the expenditure made by the consumers over time, for female groups,
expenditure was very stable, with the money being given out for a service not fluctuating
over time. The exception being low income old women, who seemed to be more flexible in
terms of paying out for the service early on, but over time, expenditure decreased.
In terms of the number of tool units used: car ownership (especially small luxurious car) is increasing particularly amongst the low income old men, who use bike as the main transport mode (the prices of the services that employ these tools are increasing). Similarly, the use of small economic cars amongst mid-income young men, whilst fairly small at the outset, grew increasingly rapidly over time. Small luxurious car use amongst high income old women was also fairly stable, though not as popular as for the same income grouping of men. Usage of a variety of vehicles namely the medium economic and luxury cars, and the large economic and luxury cars was highest for the high income old men. The small luxurious car was the most popular car across all of the groups, with mid income young women providing the majority of users.

In terms of the type of service used, small luxurious car-sharing was the most popular service, favoured especially by mid income young men and the low income old women. For the former, an increase in service units used was initially experienced, before peaking and declining back to initial levels of around 8000km. Both high income groups used no service units, neither did the mid income young women. Both small luxurious car-sharing and medium economy car-sharing were used by mid income young men initially, but both experience decline in units used to zero fairly early on in the model run. All services initially used by low income old men also dropped to zero early in the model run. Small luxurious car-sharing was favoured most by the low income old women. In total mid income young men used the most service units, followed by low income old women.

In terms of the environmental impact that each consumer group had in the model, the mid-income young women appeared to have the largest environmental impact across the majority of parameters. Looking at the consumer attributes, this may well be because they were understood to be conservative, with little openness to innovation or trying newer, perhaps less environmentally impactful activities. With the exception of climate change, high income old men had the next highest impact. The low income old women had the lowest impact, suggesting that there may be a correlation between wealth and environmental impact demonstrated by the model. The least variation seen within groups for environmental impact was in the high income old women and the mid income young women. For all the environmental impact parameters, men appeared to be more impactful than women.

The 2013/14 CarPlus survey reported that nationally (not just in London) 67% of car club members were male and 30% were female, compared to a split of 54% male and 46% female amongst national licence holders in 2012. In terms of age, 71% of car club members are between the ages of 21-44, with 31% of this group formed of 35-44 year olds (CarPlus, 2014).

An analysis of the importance of income does not feature in the CarPlus survey, so it is difficult to ascertain the extent to which the importance accorded to this social indicator demonstrated through the trends seen in the ABM data is supported by real world data. However, of the social groups identified by the CarPlus analysis, the ‘Urban Cool’ group which makes up the largest segment of survey respondents and 9% of the population have the highest propensity to be a car club member. They are well-educated and with relatively
high income, between 31-49 and living in Inner London (Ibid). Moreover the response rates for the survey were highest in the most affluent boroughs. These highlights lend support to the income as an important factor in deciding to car-share.

5.2.2 Indirect social impacts and aspects from the qualitative research

The qualitative research including expert interviews and the focus group discussion conducted as part of the SMR provided useful insights into the social aspects of servicizing in mobility as well as the governance aspects of the social indicators we identified. The specific indicators that we addressed through the interviews and the discussion are increasing public participation and maintaining accountable governance. As already discussed in the Del 5.1, our research revealed that there is an asymmetry of information between the (potential) users and government and businesses when it comes sharing practices in the mobility sector. It is important to address these issues to fully capture the potential impacts of servicizing in urban mobility in London.

From the insights provided by the discussions, it can be observed that there are two issues on the users’ side. First, there is a lack of clarity in the definitions of car-sharing practices. Unlike policymakers and businesses, potential users of public transport and sharing services perceive the new services in terms of their actual needs. The way the participants of the focus group define sharing practices in mobility reveals how they integrate their own perspectives into the available mobility services. A middle-aged non-driving man responds to the question “What do you understand by sharing transport?” by “Get a lift essentially…”, while a middle-aged woman who shares a car with her neighbours for affordability reasons says, “Saving money…”. The man’s need of others to drive him and the woman’s prioritisation of affordable commuting are clearly reflected in how they define sharing transport.

While the immediate responses entail personal needs, a relatively late response is “helping the environment.” Considering that this comes from a retired man with two cars who prioritises affordability and convenience over environmental concerns, it implies that the potential users also have a certain way of imagining what the policy and the emerging sharing practices are trying to do. The commonality between the definitions based on personal needs and an imagined goal of the mobility sharing practices is that the practice is defined by its function. Finally, the business model of car-sharing is perceived to be complex to the participants: “[referring to a commercial back-to-base car club in London]... same as hiring a car I guess, but it is actually sharing with people you don’t know.” Almost, no one in the group was able to explain what it actually is and how it works. This is something that also came up in the expert interviews: the commercial car clubs are still not well known to the local population in London (Edgar, 2013; Kennedy, 2013).

Related to the lack of clarity in what the practice of car-sharing really is, the second concern on the potential user side is the lack of trust. Having explained the service briefly, the first set of questions from the participants concerned the location of the cars, security, insurance and accidents. In the context of bike-sharing, a middle-aged man with three kids is worried about the increasing accidents and the current situation of cycling in London says, “If you are
providing the bikes, you should also provide the sense of using the bike”. He particularly points to the poor decision-making regarding cycling in London. The other participants also think that the local authorities do not necessarily work towards making the mobility practices more secure.

The trends are different on the businesses and government side. As briefly mentioned in Del 5.1, the existing institutions are struggling to deal with the requirements of the business model of car-sharing. While the regulation of bike-sharing is more straightforward than car-sharing as it is almost part of the public transport system in London, regulating car-sharing remains a puzzle to TfL. The peculiar nature of the governance system in London – the city is governed through 33 Boroughs with different parking regulations – adds to this complexity. The existing back-to-base car clubs are finding it difficult to negotiate with different Boroughs. In fact, a floating car-sharing scheme, which requires higher levels of parking flexibility, had to stop its operations in London in May 2014 due to this complexity.

Another important trend revealed on the government and business side is how the public is imagined. Both the public bodies and businesses agree that newly emerging forms of mobility practices including vehicle sharing and the use of mobile phone applications are mainly targeted at young professionals, who do not want the hassle of owning a car in densely-populated London. It should also be noted that businesses seem to be ahead of the other key players in the city: one of the major back-to-base car clubs has recently started operating in student cities like Oxford and Cambridge. This is based on the expectation that they will get used to, or at least get familiarised with, their services when studying and continue using them when they start working in London (Edgar, 2013).

This last point already reveals some of the governance implications of the car-sharing business model in London. If car clubs are aimed at moving away from private car ownership towards the provision of mobility as a service (as indicated in the case definition of SMR), the rebound effects of encouraging car-sharing should be carefully considered. Although it may not be the intention, encouraging public transport users to utilise car-sharing is an unwanted outcome as they will be adding to the vehicles on the road, while reducing car ownership by encouraging car-sharing should be encouraged. Car-sharing as an addition to the public transport thus requires an integrated vision between the public and private bodies.

In addition to this potential impact of the current form of governance of car clubs in London, our research yields three important positive aspects into the social indicators. First, both the expert interviews and the focus group discussion point to the pricing regime and how the pricing of the car-sharing business model differs to conventional pricing forms of paying for maintaining and operating one’s own car. The participants of the focus group were astonished with the low levels of hourly prices of the back-to-base car-sharing services given the high costs of parking prices in London. They would like to know what they are charged for and question the pricing regime by trying to understand whether there is a negotiation between the car clubs and the local governments for reduced parking costs. This was an important discussion that the participants were interested in. They also questioned why parking in London is very expensive in the first place if it can be done at a cheaper rate. This
criticism was based on the assumption that there exist special agreements between the local authorities and the businesses for reducing the parking fees. And lends support to the argument for a need for increased transparency in the business models and governance arrangements for new and existing sharing schemes.

In addition to increasing awareness about the pricing regime, the use of ICT, particularly in bike-sharing, has resulted in increased trust in the services provided. The mobile phone applications of the bike-sharing scheme in London was particularly praised and were used as an example for the emerging car-sharing practice: “Car clubs should work like the cycle hire scheme” says a bike-sharing scheme member stressing the importance of information regarding availability of cars in the existing schemes. This also applies to broad use of ICT in public transport, which is one of the important elements of the SMR case definition: “The whole Oyster thing has really changed perceptions about how quickly you can do things!”

Finally, the scanning exercise as part of the focus group revealed that the potential users value the immediacy of the realisation of the impacts of the services they are using. This is another positive impact that sharing services and the use of ICT in mobility can bring about. The realised impacts of using mobility services and car- and bike-sharing are more immediate as opposed to vehicle ownership and these help users to be more conscious of their travel patterns as mentioned by the participants. One of the participants stressed the present lifestyles saying that “We live in an ‘I want it now’ culture”. The following discussion also implies that they are happy to give up control in terms of ownership for learning more about their travel patterns.

In this respect, the requirements of TfL for car clubs to operate in London also lead to realising positive impacts. As explained in Del 5.1, the organisation called Carplus is responsible for accreditation of the car clubs in London. The regulations require the car fleets to be low-emission and of certain age. Moreover, Carplus conducts annual surveys with the existing car club users in London to identify the patterns of their usage (e.g. distance travelled) and how the overall emissions change as a result of changing the car clubs. Although the institution acts as an advocate of the car clubs in the UK and its surveys should therefore be carefully considered, the consideration of the survey results based on the participants provide a more transparent regime.

One of the important implications of the SMR has been its implications for the changes in employment patterns. We started the research by hypothesising that the shift to servicizing from production would result in changes to nature of employment practices in the car manufacturing and mobility service industry. In fact, when identifying the indicators that require attention in the shift to servicizing in mobility, we particularly considered the social policy implications with a focus on changes in employment. However, as discussed in the Del 5.1, the current market situation in London entails a relatively stronger focus on consumers than on the producers/service providers’ side: the market is currently consumer-driven as the key car manufacturers are already in the market and there exists almost no service providers without any affiliation with the car manufacturers. In short, there is no shift from producing to servicizing, but a combination of business models in the London market.
Therefore, the current research is inadequate to understand the implications of the internal strategies towards servicizing.

Overall, from the qualitative research, it can be concluded that the increase in the use of services and ICT has the potential to increase awareness and concerns over governance and transparency of the negotiations between the local public authorities and the businesses. These positive implications of the shift to servicizing are crucial matters to note in the policy packaging process.

6. Main Conclusions

6.1 Summary of the results

When tested in the ABM, the decoupling indicator (emissions and/or energy use per unit of revenue and income from car club sector growth) demonstrated that with less servicizing, there were more emissions and negative economic growth, suggesting that the decrease in servicizing would lead to a decrease in environmental impact. It would however be misleading to conclude that economic growth also declines with less servicizing, due to the caveats about vehicle production contained in the model, although consumer income and producing businesses revenue is negative with lower levels of servicing.

The model demonstrated that vehicle and fuel choice, as well as the size of the vehicle are important considerations. Looking at the number of tools units used over the simulation, we can observe that small cars including both luxurious and economic cars and medium and large luxurious cars are the most used cars. As sharing service price increases, vehicle ownership levels rise and the inclination towards luxury vehicles in both the market and in the car-sharing service highlights an increased environmental impact from these vehicles.

In terms of social impacts, income was seen to be the most important factor, whilst age had no clear impact over the social impacts that were considered in the ABM. Low income women were shown to be particularly disadvantaged in the model.

Car ownership (especially small luxurious car) is increasing particularly amongst low income old men and the use of small economic cars amongst mid-income young men, whilst fairly small at the outset, grew increasingly rapidly over time. Indeed, the small luxurious car was the most popular car across all of the groups. Both high income groups (male and female) used no service units and in total mid income young men used the most service units, followed by low income old women.

High income old men had the largest environmental impact across the majority of parameters, with the exception of climate change. The low income old women had the lowest impact, suggesting that there may be a correlation between wealth and environmental impact demonstrated by the model. For all environmental impact parameters, men appeared to be more impactful than women.
The interviews and focus group discussions highlighted that there is a lack of clarity in the definitions of car-sharing practices and the business model of car-sharing is perceived to be complex. Furthermore, there is a lack of trust of car-sharing services.

Institutionally there are issues too, the business model of car-sharing challenges conventional notions and practices, the fragmented governance landscape also adds to the complexity of establishing such a system. Finally, regulatory frameworks need to be modified to accommodate the required changes. Raising awareness and providing information about car-sharing were seen to be important, and the use of ICT to facilitate such measures was highlighted.

### 6.2 Policy implications and methodological limitations

One of the main limitations of the modelling process is the limited understanding of the sensitivity of the key separate parameters in inducing changes during the simulation. We therefore had to identify the possible causes as a team based on our interpretation of the data and the results together. It is an important implication of the ABM results that needs careful attention, as the end products of the project are the policy packages based on the inspirations provided by the ABM and other qualitative research.

Looking at the data and the results, the negative cash balance of the PBs are likely to be caused by the parking and congestion charging costs. Parking and road charging policies have thus been identified to have potentially particularly important roles in affecting change in the sharing economy. And the effects of these policies should be better understood and will be investigated through the policy packaging exercise in the next step. A major justification for this focus is the significant revenue that is derived by local authorities for implementing these policy measures.

This can be linked with another limitation of the ABM that it cannot account for the changes in government revenue that we identified as important to consider as most of the costs incurred by the businesses can be regarded as public revenue. According to a recent report from the RAC Foundation, in total, the London Boroughs collectively generated £293 million in profit from parking revenues in the last 12 months, once costs for maintenance and service had been taken into account (RAC Foundation, 2014). And in terms of the congestion charge, £235 million in revenue was generated over the period 2013/4 – (TfL, 2014), though most of the revenue generated by the scheme is reinvested in public transport improvements across the network. Future research should identify the share of this revenue provided by the car-sharing companies.

In addition to these two broad limitations that need consideration in the next policy packaging steps, one important inconsistency between our case definition and the model are how the consumption bundles are defined and what it means for the next steps. The SMR intended to investigate the move towards servicizing including car and bike-sharing and public transport with the aim of moving away from car ownership. While the decoupling indicator in terms of number of cars and associated economic and environmental impacts are provided by the ABM, the combination of consumption models are not accounted for in
the model. This is an important limitation given the dynamic nature of mobility systems and the role of needs met by a diverse range of mobility assets and services. Moreover, due to scale issues and hence the illogical results obtained by the ABM, the consideration of the ABM bike-sharing results has not been possible. While we strongly recommend that future ABM research in this area should focus on constructing consumption bundles accounting for different needs, it is also important to stress the limitations of the survey approach chosen for the project. Given that there are several different types of needs across social groups, it is almost impossible to understand the social complexity of moving away from car ownership through structured questionnaires. In fact, the consumer analysis and the questionnaire design limited the understanding of different types of servicizing options such as bike-sharing and the geographical conditions and accessibility that we identified as crucial in social impacts.

Nonetheless the research conducted demonstrates that there is potential for servicizing to become integrated into the mobility sector and indications are that with considered governance framings, awareness raising and an understanding of consumer needs, widespread car-sharing schemes have the potential to reduce a range of environmental impacts over time.
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SPREE Project
SERVICIZING POLICY FOR RESOURCE EFFICIENT ECONOMY

Appendix

List of Appendices

A. LCA data for the London Case
B. ABM data sources and assumptions for the UK – This includes the economic, environmental and behavioural data & assumptions for the UK case.
C. The guidelines employed for the business and expert interviews (Akyelken, et al., 2014)
D. The focus group discussion materials (Akyelken, et al., 2014)
E. Consumer Survey (Developed by TAU in cooperation with UOXF)
F. Experts interview list
Appendix A: LCA Data for the London Case

The tools in the mobility sector were selected as the car models in the car clubs in the different location, as well as bikes. The car models used for Oxford case, chosen based on car fleet offered by Oxford's ZipCar. The chosen models are listed in the Error! Reference not found. together with their key model parameters, such as CO\textsubscript{2} emissions per km, fuel consumption and curb weight.

<table>
<thead>
<tr>
<th>Type</th>
<th>Car model</th>
<th>Engine type</th>
<th>g CO\textsubscript{2}/km</th>
<th>l of fuel /100 km</th>
<th>Curb weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Vauxhall Corsa (3 door)</td>
<td>1.0i 12v 65PS ecoFLEX</td>
<td>120</td>
<td>5.2</td>
<td>1100</td>
</tr>
<tr>
<td></td>
<td>Volkswagen Up!</td>
<td>1.0 L 60PS (BMT\textsuperscript{**})</td>
<td>105 (95)</td>
<td>4.6 (4.1)</td>
<td>929</td>
</tr>
<tr>
<td></td>
<td>Volkswagen Up! ASG\textsuperscript{*}</td>
<td>1.0 L 60PS</td>
<td>103</td>
<td>4.5</td>
<td>960</td>
</tr>
<tr>
<td>Medium</td>
<td>Audi A3</td>
<td>1.2 TFSI 105PS (ss)</td>
<td>127</td>
<td>5.5</td>
<td>1225</td>
</tr>
<tr>
<td></td>
<td>Ford Focus</td>
<td>1.0 EcoBoost 100PS (ss)</td>
<td>109</td>
<td>4.7</td>
<td>1270-1700</td>
</tr>
<tr>
<td></td>
<td>Volkswagen Golf</td>
<td>1.2 TSI 105PS</td>
<td>114</td>
<td>4.9</td>
<td>1210-1229</td>
</tr>
<tr>
<td></td>
<td>Volkswagen Golf DSG\textsuperscript{*}</td>
<td>1.4 TSI 122PS</td>
<td>116</td>
<td>5.0</td>
<td>1225-1249</td>
</tr>
<tr>
<td>Large</td>
<td>Vauxhall Ampera</td>
<td>27 + el.</td>
<td></td>
<td>1.2 + el.</td>
<td>1732</td>
</tr>
<tr>
<td>Vans</td>
<td>Volkswagen Touran</td>
<td>1.2 TSI 105PS S</td>
<td>149</td>
<td>6.5</td>
<td>1453</td>
</tr>
<tr>
<td></td>
<td>Volkswagen Caddy Maxi</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Volkswagen Crafter</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Volkswagen Transporter</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Point to point service</td>
<td>FourTwo Smart</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Engine types are best educated guesses (not provided by the car clubs).
\textsuperscript{*} automatic transmission
\textsuperscript{**} BMT=Blue Motion Technology, fuel saving model

In addition, electric vehicle was modelled as future scenario of sharing service.

The cars' impacts included the impact of manufacturing and their end-of-life (EOL). LCA data of production and EOL was based on European data and was adapted based on car models' weights and were averaged for the defined car types for the case (small, medium, large, and point to point).

The consumables in the mobility sector are petrol-low sulphur and electricity for electric cars. Their impact includes their production and transportation to storage. In the Oxford case European LCA data was used for the Petrol and UK data for the electricity.

The service in the mobility sector was defined as km per passenger of leasing of different tools. The service impact includes the use of the tools (cars/point to point car sharing service/bike sharing/public transport/EV car sharing), and the impacts of roads and cars maintenance. European LCA data was used as basis, and CO\textsubscript{2} emissions from the use of cars were adapted to the car models detailed above, based on transportation data from the UK.
Vehicle Type Approval authority\(^2\). Impacts were assumed the same for leased cars and normal cars.

In the SPREE project, the ReCiPe method (V1.08) was used to estimate the environmental impacts. The impacts were quantified using mid-point categories. Not all impact categories were quantified in all cases. The relevant impact categories for each sector were selected based on a literature review for each case and the indicators relevant to the sector. In the review, common categories were screened in each topic. Impact categories, which were reported as significant in papers where normalization was performed, were also identified. The categories that were selected for the mobility sector are: Metal Depletion, Climate Change, Terrestrial Acidification, Human Toxicity, Photochemical oxidant formation, Particulate matter formation. In addition, Aluminium use, Nitrogen Oxide Emissions, and Carbon monoxide Emissions were estimated and used as impact categories as well, although these are taken from inventory data (LCI outputs).

The tables below give the final LCA data, used in the ABM.

**Table 7: Final LCA Data of the Tools in the Oxford Case Study**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Unit</th>
<th>Small luxury</th>
<th>Small economy</th>
<th>Medium luxury</th>
<th>Medium economy</th>
<th>Large luxury</th>
<th>Large economy</th>
<th>Electric vehicle</th>
<th>Bicycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Kg/lifetime</td>
<td>3.82E+0</td>
<td>3.82E+0</td>
<td>5.13E+0</td>
<td>5.13E+0</td>
<td>5.58E+0</td>
<td>5.58E+0</td>
<td>3.57E+0</td>
<td>6.08E+0</td>
</tr>
<tr>
<td>Metal Depletion</td>
<td>Kg Fe eq/lifetime</td>
<td>3.44E+0</td>
<td>3.44E+0</td>
<td>4.61E+0</td>
<td>4.61E+0</td>
<td>5.01E+0</td>
<td>5.01E+0</td>
<td>5.33E+0</td>
<td>4.30E+0</td>
</tr>
<tr>
<td>Fossil Depletion</td>
<td>Kg Oil eq/lifetime</td>
<td>1.71E+0</td>
<td>1.71E+0</td>
<td>2.30E+0</td>
<td>2.30E+0</td>
<td>2.49E+0</td>
<td>2.49E+0</td>
<td>1.73E+0</td>
<td>3.04E+0</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Kg CO2 eq/lifetime</td>
<td>7.17E+0</td>
<td>7.17E+0</td>
<td>9.62E+0</td>
<td>9.62E+0</td>
<td>1.04E+0</td>
<td>1.04E+0</td>
<td>4.76E+0</td>
<td>1.17E+0</td>
</tr>
<tr>
<td>Terrestrial Acidification</td>
<td>Kg SO2 eq/lifetime</td>
<td>4.02E+0</td>
<td>4.02E+0</td>
<td>5.40E+0</td>
<td>5.40E+0</td>
<td>5.87E+0</td>
<td>5.87E+0</td>
<td>2.81E+0</td>
<td>5.16E+00</td>
</tr>
<tr>
<td>Human Toxicity</td>
<td>Kg 1.4-DB eq/lifetime</td>
<td>1.82E+0</td>
<td>1.82E+0</td>
<td>2.44E+0</td>
<td>2.44E+0</td>
<td>2.66E+0</td>
<td>2.66E+0</td>
<td>8.84E+0</td>
<td>5.13E+0</td>
</tr>
<tr>
<td>Photochemical oxidant</td>
<td>kg NMVOC/lifetime</td>
<td>3.13E+0</td>
<td>3.13E+0</td>
<td>4.21E+0</td>
<td>4.21E+0</td>
<td>4.57E+0</td>
<td>4.57E+0</td>
<td>2.63E+0</td>
<td>3.56E+0</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>kg PM10 eq/lifetime</td>
<td>1.87E+0</td>
<td>1.87E+0</td>
<td>2.51E+0</td>
<td>2.51E+0</td>
<td>2.73E+0</td>
<td>2.73E+0</td>
<td>1.26E+0</td>
<td>2.58E+0</td>
</tr>
<tr>
<td>Nitrogen Oxide Emissions</td>
<td>kg NOx eq/lifetime</td>
<td>1.64E+0</td>
<td>1.64E+0</td>
<td>2.20E+0</td>
<td>2.20E+0</td>
<td>2.39E+0</td>
<td>2.39E+0</td>
<td>1.02E-01</td>
<td>2.48E-01</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>kg CO/lifetime</td>
<td>4.06E-01</td>
<td>4.06E-01</td>
<td>5.45E-01</td>
<td>5.45E-01</td>
<td>5.92E-01</td>
<td>5.92E-01</td>
<td>2.64E-01</td>
<td>6.97E-01</td>
</tr>
</tbody>
</table>

\(^2\) [http://carfueldata.dft.gov.uk/](http://carfueldata.dft.gov.uk/)
### Emissions

#### Table 8: Final LCA Data of the Consumables in the Oxford Case Study

<table>
<thead>
<tr>
<th>Consumable</th>
<th>Unit</th>
<th>Petrol. low-sulphur</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Kg/kg or kg/kwh</td>
<td>6.76E-05</td>
<td>7.94E-05</td>
</tr>
<tr>
<td>Metal Depletion</td>
<td>Kg Fe-eq/ kg or kg Fe-eq/kwh</td>
<td>1.65E-02</td>
<td>2.46E-02</td>
</tr>
<tr>
<td>Fossil Depletion</td>
<td>Kg Oil-eq/ kg or kg Oil-eq/kwh</td>
<td>1.27E+00</td>
<td>1.97E-01</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Kg CO2-eq/ kg or kg CO2-eq/kwh</td>
<td>7.29E-01</td>
<td>2.14E-04</td>
</tr>
<tr>
<td>Terrestrial Acidification</td>
<td>Kg SO2-eq/ kg or kg SO2-eq/kwh</td>
<td>5.00702</td>
<td>2.19E-03</td>
</tr>
<tr>
<td>Human Toxicity</td>
<td>Kg 1.4-DB eq/ kg or kg 1.4-DB eq/kwh</td>
<td>1.68E-01</td>
<td>2.14E-01</td>
</tr>
<tr>
<td>Photochemical oxidant formation</td>
<td>Kg NMVOC/ kg or kg NMVOC/kwh</td>
<td>1.50E+01</td>
<td>1.39E-03</td>
</tr>
<tr>
<td>Particulate matter formation</td>
<td>Kg PM10-eq/ kg or kg PM10-eq/kwh</td>
<td>1.90E-03</td>
<td>7.15E-04</td>
</tr>
<tr>
<td>Nitrogen Oxide Emissions</td>
<td>Kg Nox/ kg or kg Nox/kwh</td>
<td>2.11E-03</td>
<td>1.17E-03</td>
</tr>
<tr>
<td>Carbon monoxide Emissions</td>
<td>Kg CO/ kg or kg O/kwh</td>
<td>8.37E-04</td>
<td>2.26E-04</td>
</tr>
</tbody>
</table>

#### Table 9: Final LCA Data of the Services in the Oxford Case Study

<table>
<thead>
<tr>
<th>Service</th>
<th>Unit</th>
<th>Small economic car sharing (back-to-base)</th>
<th>Small luxurious car sharing (back-to-base)</th>
<th>Medium economic car sharing (back-to-base)</th>
<th>Medium luxurious car sharing (back-to-base)</th>
<th>Large economic car sharing (back-to-base)</th>
<th>Large luxurious car sharing (back-to-base)</th>
<th>Bike-sharing service</th>
<th>EV sharing service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Kg/Km per vehicle</td>
<td>3.08E-01</td>
<td>2.31E-01</td>
<td>4.05E-01</td>
<td>3.04E-01</td>
<td>4.05E-01</td>
<td>3.04E-01</td>
<td>3.38E-02</td>
<td>3.08E-01</td>
</tr>
<tr>
<td>Metal Depletion</td>
<td>Kg Fe eq/ Km per vehicle</td>
<td>6.61E+01</td>
<td>4.96E+01</td>
<td>8.71E+01</td>
<td>6.53E+01</td>
<td>8.71E+01</td>
<td>6.53E+01</td>
<td>2.00E+00</td>
<td>6.61E+01</td>
</tr>
<tr>
<td>Fossil Depletion</td>
<td>Kg Oil eq/ Km per vehicle</td>
<td>3.58E+02</td>
<td>2.68E+02</td>
<td>4.71E+02</td>
<td>3.53E+02</td>
<td>4.71E+02</td>
<td>3.53E+02</td>
<td>3.66E+00</td>
<td>3.58E+02</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Kg CO2-eq/ Km per vehicle</td>
<td>5.33E+03</td>
<td>4.00E+03</td>
<td>5.20E+03</td>
<td>3.90E+03</td>
<td>7.21E+03</td>
<td>5.41E+03</td>
<td>8.55E+00</td>
<td>5.33E+03</td>
</tr>
<tr>
<td>Terrestrial Acidification</td>
<td>Kg SO2 eq/ Km per vehicle</td>
<td>5.10E+00</td>
<td>3.82E+00</td>
<td>6.53E+00</td>
<td>4.90E+00</td>
<td>6.53E+00</td>
<td>4.90E+00</td>
<td>3.03E+02</td>
<td>5.10E+00</td>
</tr>
<tr>
<td>Human Toxicity</td>
<td>Kg 1.4-DB eq/Km per vehicle</td>
<td>3.31E+02</td>
<td>2.48E+02</td>
<td>4.33E+02</td>
<td>3.25E+02</td>
<td>4.33E+02</td>
<td>3.25E+02</td>
<td>2.28E+00</td>
<td>3.31E+02</td>
</tr>
<tr>
<td>Photochemical oxidant formation</td>
<td>Kg NMVOC/ Km per vehicle</td>
<td>1.21E+01</td>
<td>9.05E+00</td>
<td>1.43E+01</td>
<td>1.07E+01</td>
<td>1.43E+01</td>
<td>1.07E+01</td>
<td>4.74E+02</td>
<td>1.21E+01</td>
</tr>
<tr>
<td>Particulate matter formation</td>
<td>Kg PM10 eq/ Km per vehicle</td>
<td>3.49E+00</td>
<td>2.62E+00</td>
<td>4.51E+00</td>
<td>3.38E+00</td>
<td>4.51E+00</td>
<td>3.38E+00</td>
<td>1.47E-02</td>
<td>3.49E+00</td>
</tr>
<tr>
<td>Nitrogen Oxide Emissions</td>
<td>Kg Nox/Km per vehicle</td>
<td>4.84E+00</td>
<td>3.63E+00</td>
<td>6.06E+00</td>
<td>4.54E+00</td>
<td>6.06E+00</td>
<td>4.54E+00</td>
<td>2.57E+00</td>
<td>4.84E+00</td>
</tr>
<tr>
<td>Carbon monoxide Emissions</td>
<td>Kg CO/Km per vehicle</td>
<td>4.35E-02</td>
<td>3.26E-02</td>
<td>5.73E-02</td>
<td>4.30E-02</td>
<td>5.73E-02</td>
<td>4.30E-02</td>
<td>2.64E-02</td>
<td>4.35E-02</td>
</tr>
</tbody>
</table>

#### Table 10: Final LCA Data of the Transportation Service in the Oxford Case Study

<table>
<thead>
<tr>
<th>Service</th>
<th>Unit</th>
<th>Public Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Kg/Km per passenger</td>
<td>9.99E-05</td>
</tr>
<tr>
<td>Metal Depletion</td>
<td>Kg Fe eq/ Km per passenger</td>
<td>2.77E-03</td>
</tr>
<tr>
<td>Fossil Depletion</td>
<td>Kg Oil eq/ Km per passenger</td>
<td>3.48E-02</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Kg CO2-eq/ Km per passenger</td>
<td>1.04E-01</td>
</tr>
<tr>
<td>Terrestrial Acidification</td>
<td>Kg SO2 eq/ Km per passenger</td>
<td>6.72E-04</td>
</tr>
<tr>
<td>Human Toxicity</td>
<td>Kg 1.4-DB eq/Km per passenger</td>
<td>2.94E-02</td>
</tr>
</tbody>
</table>

37


### Table 11: Data Sources for the LCA Data in the Oxford Case Study

<table>
<thead>
<tr>
<th>Modelling Object</th>
<th>Dataset/Type of Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions of cars</td>
<td>[Kg CO₂]</td>
<td><a href="http://carfueldata.dft.gov.uk/">http://carfueldata.dft.gov.uk/</a></td>
</tr>
<tr>
<td>Oceanic transportation distances</td>
<td>Distances [km]</td>
<td><a href="http://www.searates.com/reference/portdistance">http://www.searates.com/reference/portdistance</a></td>
</tr>
<tr>
<td>Vauxhall Corsa</td>
<td>transport, passenger car, electric, LiMn2O4, certified electricity</td>
<td>Ecoinvent V2.2</td>
</tr>
<tr>
<td>VW UP</td>
<td>passenger car, petrol/natural gas (GLO)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>VW UP ASG</td>
<td>passenger car, petrol/natural gas (GLO)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>Audi A3</td>
<td>passenger car, petrol/natural gas (GLO)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>Ford Focus</td>
<td>passenger car, petrol/natural gas (GLO)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>Volkswagen Golf</td>
<td>passenger car, petrol/natural gas (GLO)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>Volkswagen Golf DSG</td>
<td>passenger car, petrol/natural gas (GLO)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>Vauxhall Ampera</td>
<td>passenger car, petrol/natural gas (GLO)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>Volkswagen Touran</td>
<td>Transport, passenger car, small size, petrol, EURO 5 (RER)</td>
<td>Ecoinvent V3</td>
</tr>
<tr>
<td>Public transportation</td>
<td>CH: transport, regular</td>
<td>Ecoinvent V2.2</td>
</tr>
<tr>
<td>Modelling Object</td>
<td>Dataset/Type of Data</td>
<td>Source</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Bikes</td>
<td>CH: transport, bicycle</td>
<td>Ecoinvent V2.2</td>
</tr>
<tr>
<td>Electricity - UK</td>
<td>electricity, production mix GB</td>
<td>Ecoinvent V2.2</td>
</tr>
</tbody>
</table>

Modelling Object Dataset/Type of Data Source
Appendix B: ABM data sources and assumptions for the UK: Economic and behavioural data

The ABM case completion consisted of two stages:

1- Configuration of the ABM excel sheet:
This task has been a collective process since the beginning of the SMR. The ABM agents were first identified by the case definition provided by the OXF team. Throughout the research, the initial case has altered both due to the modelling limitations and the changes to the case.

Once the economic and environmental data is completed, a calibration run (with made up consumer data) was conducted by the Delft team that led to several changes over April – November 2014. The following discussion between the mobility and the modelling teams after the first calibration run illustrates the process of completing the configuration and the data:

Question: How many ticks/BTUs/weeks should a single simulation run take? (The dimensioning of run length with strategic reconsideration periods is important for observing agent behaviour.)

- OXF: Given the length of the trial periods of the car clubs and what the focus group participants said in terms of when they would know whether they’d like to switch to car-sharing, 3 months seems to be a reasonable run, so can we can try 12 ticks.
- Delft: That is much too short, because we want to let the agents have multiple strategic reconsiderations in one simulation. With ‘economic’ Consumer agents having a strategic reconsideration period of 52 weeks, the simulation run should take at least a couple of years

2- Completing the economic, behavioural and environmental data into the ABM excel sheet

Behavioural data:
The behavioural data was collected through a survey conducted in London. The questionnaire and the analysis were primarily conducted by the TAU team in light of the indicators provided by the OXF team. The role of OXF was to provide the mobility-specific insights throughout the process and run the pilot survey in Oxford followed by extensive feedback particularly on the choice task.

In the questionnaire conducted in London, the questions 16-18 were also inserted by the OXF team. Both taken from the I-Connect survey, the question 16 asks about the vehicles the respondent owns and the question 18 aimed to understand the characteristics of the neighbourhood. Aimed at understanding the behavioural changes of the infrastructure interventions, the I-Connect is an UK Engineering and Physical Sciences Research Council project completed last year (http://www.iconnect.ac.uk). The question 16 in this survey was particularly important in the SPREE case as it makes a distinction between the actual and the
perceived behaviour. While some travel surveys ask such questions about regular consumptions by asking “On average, how much...?”, this survey picks a random week and asks the respondent what they actually did during that week. The question 18 was included as it was considered to be important to understand the indicators regarding accessibility and geographical outcomes. The rest of the questionnaire and the analysis were prepared and conducted by the TAU team. The OXF team also provided some examples of literature that discuss statements regarding comfort, convenience, status-seeking, independence and car ownership in the context of travel behaviour (Koch, 2001; Steg, 2005) and suggested illustrative statements for views on car ownership based on the existing evidence (City CarShare, 2004; Harmer and Cairns, 2012) for TAU’s use to design the survey. The latter was particularly helpful in identifying how car ownership is replaced by car-sharing by providing evidence on the behaviour and characteristics of the current car-sharing members (e.g. number of cars in the household, availability of parking, etc.). The TAU team stated that Beck (1985) was used for attitudes towards ownership, Heinen, et al (2011) for attitudes and habits towards cycling, Dunlap, et al. (2000) for environmental attitudes and beliefs and Eastman, et al. (1999) for status-seeking and conspicuous consumption. Please refer to the generic methodology report for further details on the survey design.

As part of the survey preparing process, OXF team also provided the following immediate insights from the focus group discussion for the TAU team to design the questionnaire:

The participants include:

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Lifestage</th>
<th>Occupation</th>
<th>Household Income</th>
<th>Ethnicity</th>
<th>Modes of transport &amp; use (Q4a)</th>
<th>How many cars in the household (Q4b)</th>
<th>Schemes currently use (Q5a)</th>
<th>Schemes would consider using (Q5b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mike</td>
<td>43</td>
<td>Family</td>
<td>Furniture Designer</td>
<td>£55,000.00-£65,000 per annum</td>
<td>White Caucasian</td>
<td>A bike, A scooter/moped, A car</td>
<td>One</td>
<td>Carpooling</td>
<td>Car Sharing Schemes, Bike Sharing Schemes</td>
</tr>
<tr>
<td>Tanya</td>
<td>34</td>
<td>Young Single</td>
<td>Publisher</td>
<td>£55,000.00-£45,000.00 per annum</td>
<td>Indian Caucasian</td>
<td>A bike</td>
<td>N/A</td>
<td>Carpooling</td>
<td>Car Sharing Schemes, Flat/ House Sharing Schemes</td>
</tr>
<tr>
<td>Susan</td>
<td>73</td>
<td>Empty Nester</td>
<td>Retired Post Office Worker</td>
<td>£15,000.00-£25,000.00 per annum</td>
<td>White Caucasian</td>
<td>None listed</td>
<td>N/A</td>
<td>None listed</td>
<td>Car Sharing Schemes</td>
</tr>
<tr>
<td>Karen</td>
<td>45</td>
<td>Family</td>
<td>Receptionist</td>
<td>£55,000.00-£65,000 per annum</td>
<td>White Caucasian</td>
<td>A bike, A car</td>
<td>Two</td>
<td>Carpooling</td>
<td>Car Sharing Schemes, Flat/ House Sharing Schemes</td>
</tr>
<tr>
<td>Carly</td>
<td>30</td>
<td>Young Single</td>
<td>Dental Nurse</td>
<td>£35,000.00-£55,000.00 per annum</td>
<td>White Caucasian</td>
<td>A bike</td>
<td>N/A</td>
<td>None listed</td>
<td>Car Sharing Schemes</td>
</tr>
<tr>
<td>Gordon</td>
<td>66</td>
<td>Empty Nester</td>
<td>Semi Retired Electrical Engineer</td>
<td>£15,000.00-£25,000.00 per annum</td>
<td>White Caucasian</td>
<td>A car</td>
<td>Two</td>
<td>None listed</td>
<td>Car Sharing Schemes</td>
</tr>
<tr>
<td>Tim</td>
<td>45</td>
<td>Family</td>
<td>Civil Servant</td>
<td>£55,000.00-£65,000.00 per annum</td>
<td>White Caucasian</td>
<td>None listed</td>
<td>N/A</td>
<td>None listed</td>
<td>Car Sharing Schemes</td>
</tr>
<tr>
<td>David</td>
<td>25</td>
<td>Young Single</td>
<td>Design Engineer</td>
<td>£55,000.00-£65,000.00 per annum</td>
<td>White Caucasian</td>
<td>A car</td>
<td>Three</td>
<td>None listed</td>
<td>Car Sharing Schemes</td>
</tr>
</tbody>
</table>

General insights from the mapping exercise for the questionnaire:

- None of the participants would use car clubs for commuting except for Carly, who would use the service if it is in the form of London cycle hire scheme (live information is available) and cars can be dropped off anywhere.
• Tanya would consider car clubs for going to shops or anything outside commuting if it was close enough. There is a back-to-base car club bay 20 minute walking distance from her place. She is prepared to walk 15-20 minutes depending on the weather. She can easily get someone to drop her off under bad weather conditions.
• To Karen, car clubs would cost more money than carpooling/owning a car. And she has a hectic life that flexibility is very important for her. Her daughter might consider depending on the insurance requirements.
• David thinks walking time and driving time should be proportional. “You can’t walk for 30 minutes for an hour drive!”
• Mike is interested in using shared vans for his work, i.e. to carry stuff around.
• The participants prefer short-term contract (4-6 months). Mike and David are particularly keen on a trial period of 3-4 months to see how much they are using it. Only Gordon thinks that if the tax insurance & depreciation of his own car for one year is too much, a-year fixed term contract would be preferable. But he also prefers a 3 month contract because of the winter season! Doesn’t want to walk to the car in winter.
• All participants agree that the cars should be ready whenever they want. Some of them specify only one-minute planning through a mobile app (this is mainly due to the perception brought by the convenience of the London Oyster card & Cycle hire scheme).

The summary of the factors that would affect their decision to join a car club - appeared in the discussion in this order:
• Walking distance to cars
• Weather
• Congestion charging
• Cost
• Traffic
• Parking space
• Transparency of pricing
• Driving abilities
• Vehicle size
• Availability (to check the car availability through a mobile app)
• Insurance
• Easy to use – vehicle type
• Use of more technology is preferable
• Cleanliness (whether dogs are allowed!)
• Ownership/status
• Freedom and leisure
• Age limit
• Most subjective feelings including environmentalism come secondary.

The summary of the factors that would affect their decision to join a bike-sharing scheme - appeared in the discussion in this order:
• Safety
• Convenient in central London, not outside of London
• Theft
The participants were asked to state the 3 most important factors for choosing to become a car club member:

**Mike:**
1. Not having kids any more
2. Cost
3. Convenience (using it instantly)

**Susan:**
1. Cost
2. Convenience (prepared to walk for 5-10 minutes only)

**Tanya:**
1. Cost
2. Accessibility (can be framed as convenience to indicate the availability of the cars, parking requirements and journey planning time required)

**David:**
1. Cost
2. Insurance
3. Easiness

**Tim (non-driving):**
1. Cost
2. Public transport is easier

**Karen:**
1. I need my car!!! My life is quite hectic
2. Accessibility and walking distance

**Gordon:**
1. Too stressful
2. Convenience - Parking space/pay/bring it back/put it back
3. Cost comes secondary, but convenience comes with costs!

We present the table the TAU team provided based on the survey results in the consumer section of this data compilation.

**Economic data:**
The business data was collected through interviews and literature review. The data collected includes both numerical data and perceptions of the businesses. For some of the business data, we had to make assumptions and change the actual data considerably given the dimensions of the model. Please note that the UK model is primarily geared towards back-to-base car-sharing model. The inclusion of bike-sharing and other modes have been kept to test the market development scenarios and policies. Due to different scales of data used for bike and car-sharing and that the model did not handle the consumption bundles as it was planned to do so, the UK model is only used for car-sharing interpretation.

The rest of this section explains the economic data inserted into the ABM excel sheet in detail.
TOOL (META ID 7)

Vehicle type classification is based on the car models provided by a base-to-back car club currently operating in London. Only one type of bicycle is assumed (BIXI as used in the London cycle hire)

- Small economic car: Vauxhall Corsa
- Small luxurious car: VW Up!
- Medium economic: Ford Focus or Volkswagen Golf
- Medium luxurious car: Audi A3
- Large economic: Volkswagen Touran or Vauxhall Zafira
- Large luxurious: VW Passat (not currently available on the car club’s fleet in London, but may be used for modelling reasons)

Use time (kms):

1. Small luxurious car: 40,000
2. Small economic car: 30,000
3. Medium luxurious: 40,000
4. Medium economic car: 30,000
5. Large luxurious: 40,000
6. Large economic: 30,000
7. Electric vehicle: 40,000
8. Bicycle: 5,000
9. Leased car at all sizes: 5,363 (based on the leasing period of 9 months)

Note: note that leased car is about car leasing by PBs (not part of the B2C case-study, i.e. not available to consumers and is represented by a Tool purchased from the World Market).

Sources and assumptions:

- The uses of resources and associated wastes have been provided by TAU.
- There is almost no correct way to measure use time of the tools in this model. Since we do not make the distinction between trip purposes, we have decided to keep it as general as possible and do not distinguish between different sizes. With the current values for used cars (40,000/30,000), the lifetime of cars in the model will be 4-5 years (200-250 weeks) (given an average Consumer need of 137.5 km/week).
- The average lifetime of an owned car in reality depends if this is per owner or across all lifetime. A report from the RAC foundation (2008 data) suggests that most cars have a lifetime of 14 years, with most cars being scrapped after 20. So if we are thinking of per owner, 4-5 years is a viable assumption.
- Lifespan of bicycle component hugely vary. We therefore simplify the bike to last for 5,000 km for modelling purposes.

- LCA of leased cars: There is no information on this. The modelling team downscaled the LCA impacts for the leased car, based on the use time figures and the calculation process used for leasing the cars.

**Initial market penetration** was initially calculated using the real figures. Because they do not sum up to 1 as required by the model (model assumes that this is a single market), the real figures have been adjusted – the final figures should be taken as assumptions, not related to the real market data.

**CONSUMABLE (META ID 8)**

1. Petrol-low sulphur (as advised by TAU)

Sources and assumptions:

- The use of resources and associated wastes have been filled by TAU
- It is assumed that LCA impact of electricity is not considered, and that business providing bike-sharing do not use oil, but consumers owning a bike do.

**SERVICE (META ID 9)**

We have identified the following services to be included in the case definition – only the first 6 services are provided by the existing PB. Leasing vehicles services are only used by the P Bs. The mobility team was initially advised by the TAU team to include EV sharing and point-to-point car-sharing as the choice task & ABM integration was planned to be designed to understand the potential of the non-existing services. This was not done, but the model kept these options. Our initial model was geared towards back-to-base car-sharing by considering the potential of complementing it by public transport and bike-sharing. The model did not take into account different mobility needs, therefore the consumer choice amongst the consumption models remained crude. This needs to be addressed in interpreting the results.

1. Back-to-base sharing – small economic car
2. Back-to-base sharing – small luxurious car
4. Back-to-base sharing – medium luxurious car
5. Back-to-base sharing – large economic car
7. Bike-sharing
8. Point-to-point car-sharing service
9. Public transport
10. EV sharing service

Sources and assumptions:
Use of resources and associated wastes has been filled in by TAU.

Same assumption with the initial market penetration. For the services that are not currently provided by the producing business, 0 is assumed.

**INFRASTRUCTURE (META ID 4)**

As mentioned in almost all of the interviews, the only infrastructure needed for car-sharing is parking. In this model, no infrastructure is assumed in this case as all parking costs are included in the “Other costs based on output” and the “Structural costs” of the relevant CMs, MMs and SMs.

**WORLD MARKET (META ID 5)**

Only the tools that are currently provided by the PB (as a service) are included as well as the consumables 7 code for the tool, 1-7 for the tool type (vehicle types)

- 8 code for the consumable, 1 for the consumable type (petrol)

<table>
<thead>
<tr>
<th>Code</th>
<th>Tool Type</th>
<th>Price</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>[7 9 1800] [7 10 1000] [7 11 2700] [7 12 2000] [7 13 3700] [7 14 3000] [7 7 26490] [8 1 1.30 ]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prices of tools and vehicle taxes (one-time costs)**

This includes the price of the product and vehicle tax

1. Small luxurious car £11,245 – source: [http://www.volkswagen.co.uk/new/up-nf/which-model](http://www.volkswagen.co.uk/new/up-nf/which-model)
3. Medium luxurious £18,280 – source: [https://www.audi.co.uk/explore-models/explore-by-range/a3.html](https://www.audi.co.uk/explore-models/explore-by-range/a3.html)
5. Large luxurious £22,680 – source: [http://www.volkswagen.co.uk/new/passat-vii/which-model](http://www.volkswagen.co.uk/new/passat-vii/which-model)
8. Bike – an average UK bike price (with similar features to the London cycle hire) - £290

**Prices of consumables (pound/km)**

2. Oil per kg: 70 (Source: http://www.ukbikestore.co.uk/product/421/greenoilbikecleaner1l/green-oil-green-clean-ecological-bike-wash-1-litre.html)

Since we do not have the details of leasing agreements of the operators in London, the following leasing prices are assumed (based on the 9-month leasing period):

- small economic car - 1000
- small luxurious car - 1800
- medium economic car – 2000
- medium luxurious car - 2700
- large economic car - 3000
- large luxurious car - 3700

**MANUFACTURING MODEL (META ID 10)**

Purchasing refers to leasing in this case study.

1. Purchase a small economic car
2. Purchase a small luxurious car
3. Purchase a medium economic car
4. Purchase a luxurious medium car
5. Purchase a large economic car
6. Purchase a large luxurious car
7. Purchase a bike
8. Purchase an EV
9. Do nothing

Initially availability
Because the case is primarily defined to be a back-to-base car-sharing case with possible combinations of bike-sharing and public transport, the initial availability of purchasing EVs and bikes is assumed to be ‘FALSE’. With the policy instruments and market developments, these options may be available in the stimulated market.

**Main output**

Each MM includes the cost of acquiring (purchasing = leasing) a vehicle. The cost to the PB is not equal to the cost to the consumer, so tool (7) number 9 (leased car) is assumed to be the main output for normal cars.

**Inputs and ratio**

Because the MMs represent a purchase from the world market (i.e. not production), there is only one input (i.e. tool), the measuring unit is then 1.

**Secondary outputs and ratio**

None

**Associated product-based Sales model**

Because no product-based SMs are considered by PBs this entry is empty. If PBs can also choose to sell the same car type to consumers, then there is also a product-based SM

**Possible service-based sales models**

Represents the associated service-based sales model

E.g. purchase a small economic car is associated with providing a back-to-base car-sharing service using a small economic car

**Structural costs**

This was planned to include depreciation and repair costs. However, because the products are not produced internally, the Delft advised that this figure should be very low for calibration reasons (the actual data has been removed and the structural costs are assumed to be 100 per week). The cost of purchasing (leasing cost to the PB) is included in the WM price.

**One-time investment costs**

There is no one-time investment cost as indicated by the car club company.

**Labour time**

All labour time is assumed to be included in the SM, not in MM.

**Other costs based on output**

None
Required skills

None

Required infrastructures

None

SALES MODEL (META ID 11)

1. Provide bike-sharing
2. Provide EV sharing service
3. Provide point-to-point car-sharing
4. Provide back-to-base car-sharing (small economic car)
5. Provide back-to-base car-sharing (small luxurious car)
6. Provide back-to-base car-sharing (medium economic car)
7. Provide back-to-base car-sharing (medium luxurious car)
8. Provide back-to-base car-sharing (large economic car)
9. Provide back-to-base car-sharing (large luxurious car)
10. Sell small economic car
11. Sell small luxurious car
12. Sell medium luxurious car
13. Sell medium economic car
14. Sell large economic car
15. Sell large luxurious car
16. Sell bike
17. Public transport

All 'sell' SMs (ID 10 and further) are currently SMs that PBs won't consider. Therefore, these SMs are quite empty, and do not require input data (this does not hold for corresponding Products and CMs). (We need these SMs, because CAs only look at offers located in SMs.) The 'non-PB SMs' should have their 'corresponding MM' property set to "N/A"!

Initial availability

The SMs that do not include back to base car-sharing are assumed to be unavailable in the UK market due to illogical results obtained by the first ABM run. These can be changed by policy and market scenario developments.

Consumed/priced in proportion to customer need – set to TRUE following the advice from Delft team

Corresponding manufacturing model – for point-to-point service, only medium luxurious cars are considered

Main output
Insert the corresponding services

**Secondary inputs and ratios/secondary outputs and ratio**

Fuel consumption for the car-based SMs.

Bike-sharing and EV sharing have been left blank (G132 and H132) as there is no economic data we can estimate.

**Use time modifier**

This is set to 1 as suggested by the Delft. The use time modifier for EVs and bikes is irrelevant, because the PBs cannot both provide EV/bike selling and sharing.

**Structural costs**

Structural costs set to 0 as suggested by the Delft. The costs indicated by the car club were inserted into the ‘Other costs based on output’ as the unit is decided to be the km.

**One-time investment costs**

None

**Labour time**

According to the data provided by the car club company, in terms of UK operation, 80FTE – because the measuring unit of output is 1 km of inner-city transportation, we assume that for providing one week of service, 80/52 (1.54) FTE is required. Because we cannot distinguish between how much labour time is spent on acquiring the vehicles, we include it here in the MM, not in the SM. Bike and EV are assumptions.

**Other costs based on output**

The data provided by the company includes parking, congestion charging costs to the PB (for the current fleet size), ICT, cleaning, security, customer services and office rent - all per week for back-to-base car clubs. For privacy reasons, we do not provide the actual data. Data is not available for other services - they were not included in the main interpretation. Because the actual figures were too high for the PBs to be able to make a profit given the model characteristics, it was decided that the costs should relate to one vehicle per kilometre. The figures inserted into the model are 0.08, 0.34, 0.32, 0.3, 0.3, 0.3, 0.3, 0.3.

**Required infrastructures**

None

**Scores on preferences**

<table>
<thead>
<tr>
<th>Service</th>
<th>High standard</th>
<th>Walking time</th>
<th>Availability</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bike-sharing</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>
SKILL (META ID 13)

We only consider driving. Average cost of obtaining a driving license in the UK is £1,000

RESOURCE

This has been filled by the TAU team.

CONSUMPTION MODEL (META ID 12)

1. Use of small luxurious car only
2. Use of small economic car only
3. Use of medium luxurious car
4. Use of medium economic car
5. Use of large luxurious car
6. Use of large economic car
7. Share a small economic car
8. Share a small luxurious car
9. Share a medium economic car
10. Share a medium luxurious car
11. Share a large luxurious car
12. Share a large economic car
13. EV sharing
14. PT only
15. Bike-sharing only
16. Use own bicycle
17. Point-to-point car-sharing
18. Use of small car + PT
19. Use of large car + bike-sharing
20. Use of EV only

Initial availability

The case assumes that only using your own car and back-to-base car-sharing are available to the consumer.

Consumption bundle

No consumption bundles are incorporated into the UK case as the model assumptions are too crude.
Automatic repurchase

FALSE for all except for all sharing options and public transport

Consumed in proportion to need

TRUE – should be the same as the SM

Main input and ratio

Same as the corresponding SMs

Secondary inputs and ratio

1 unit of need: 1 km of transportation

Small economic car: 0.086 (Source: http://www.autodata.net/en/?f=showCar&car_id=2114)

Small luxurious car: 0.047 (Source: http://en.wikipedia.org/wiki/Volkswagen_Up)

Medium economic car: 0.093 (Source: http://carsfuelconsumption.com/ford-focus-fuel-consumption-miles-per-gallon-or-litres-km/)

Medium luxurious car: 0.091 (Source: http://carsfuelconsumption.com/audi-s3-fuel-consumption-liters-or-gallons-km-or-miles/)

Large economic car: 0.052 (Source: http://www.volkswagen.co.uk/new/touran-gp-ii/which-model/engines/overview)

Large luxurious car: 0.053 (Source: http://www.volkswagen.co.uk/new/passat-estate-vii/which-model/engines/overview)

It is assumed that 1 litre of cleaning oil is required for 1 km of cycling

Secondary output and ratio

No secondary output

Revenue improvement multiplier

Set to 1 if not Consuming Business.

Structural costs

Permitting + maintenance costs per week (GBP)

Use of own cars = assuming one with residential parking goes into the congestion charge zone area twice a week and takes his/her own to a service once year, on average £40/week is expected to be spent on using one’s own car in London.

Use of bike = yearly maintenance (£3/week)
No costs are assumed for PT given the dimensions & assumptions of the model.

**One-time investment costs**

This includes GPS + accessories for cars + helmet for bikes + cost of car itself (as the cars are not provided by the PBs) + vehicle tax

Vehicle tax rates are added to the prices of products in the World Market

Annual membership for car clubs (regardless of size of vehicle used subsequently) £60 - http://www.citycarclub.co.uk/about/what-does-it-cost/personal

Membership fees (annual) for both EV sharing and bike-sharing have been added:

- EV sharing= £50 based on e-car’s annual membership fee. http://www.e-carclub.org/rates/
- Bike-sharing = £70 London: https://www.tfl.gov.uk/modes/cycling/barclays-cycle-hire/what-you-pay

Bicycles are assumed to cost £290

**Labour time**

None

**Other costs based on output**

None

**Required skills**

Only driving is relevant

**Required infrastructures**

No infrastructure is assumed.

**Scores on preferences**

<table>
<thead>
<tr>
<th>Use:</th>
<th>High standard</th>
<th>Walking time</th>
<th>Availability</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small luxurious car</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Small economic car</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Medium luxurious car only</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Medium economic car</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Large luxurious car</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Large economic car</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Share a small economic car</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Share a small luxurious car</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Share a medium economic car</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Share a medium luxurious car</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Share a large luxurious car</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Share a large economic car</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>EV sharing</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>PT only</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Bike-sharing only</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Use own bicycle</td>
<td>3</td>
<td>6</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Point-to-point car-sharing</td>
<td>8</td>
<td>8</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>----------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Use of EV only</td>
<td>8</td>
<td>10</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

**PRODUCING BUSINESS (META ID 1)**

**Initial business models, offer prices, and number of agents**

\[
\begin{array}{lllllll}
1 & 2.5 & "N/A" & "N/A" & 4 & 0.5 & 1 \\
2 & 2.5 & "N/A" & "N/A" & 5 & 0.5 & 1 \\
3 & 2.5 & "N/A" & "N/A" & 6 & 0.55 & 1 \\
4 & 2.5 & "N/A" & "N/A" & 7 & 0.6 & 0 \\
5 & 2.5 & "N/A" & "N/A" & 8 & 0.65 & 0 \\
6 & 2.5 & "N/A" & "N/A" & 9 & 0.75 & 0 \\
\end{array}
\]

- Prices are per unit of product (car, bike) or unit of functional service (1 km). It is assumed in the model that there are 6 PBs each with a different MM (1-6), with a capacity of 10 (10 cars can be purchased by each PB per week). Please note that initial capacity is not important for this case as the PBs do not produce cars. After the model calibration, the actual prices were divided by 10 and the price of small economic car-sharing has been increased, so that not all consumers choose this Service initially.

**Initial fraction of PBs that have the option to connect to each of the Infrastructures/ Initial fraction of 'enabled' PBs that are actually connected to each of the Infrastructures**

None

**Initial skills**

None

**Fraction of willingness to sacrifice expected profit for 1 point higher Preference fit ('strategic fit')**

Since this is a very small market and the companies are making a loss, they are more interested in sustaining customers rather than making a profit. “Word of mouth recommendations from our existing customers to prospective customers… people who value our service know, live with and socialise with other people who would value our service.”

We assumed this would correspond to 0.3.

**Weights for preferences**

Assumptions based on the interviews and the ranking provided by the company
Fraction of consuming agents questioned during market research

This is a model assumption

Risk aversion factor in market research

This figure is based on the existing market situation - given that most service providers are operating at a loss/marginal profit, they are unlikely to risk averse.

Return-on-investment period

This figure is based on the information provided by the car club operator - "in a mature market like London, it is 2 years, in a new market in Europe 4 or 5 years"

Period after which PB reconsiders a strategic change

This figure (260) is based on the insights from the interviews and what the car club has done previously.

Period after which PB reconsiders offer price of Product/Service

This figure (104) is based on the insights from the interviews and what the car club has done previously.

CONSUMER (META ID 2)

The following table was composed by the TAU team based on the survey results conducted in London.

<table>
<thead>
<tr>
<th>Consumer Group 1</th>
<th>Consumer Group 2</th>
<th>Consumer Group 3</th>
<th>Consumer Group 4</th>
<th>Consumer Group 5</th>
<th>Consumer Group 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>men</td>
<td>men</td>
<td>Women</td>
<td>women</td>
<td>women</td>
</tr>
<tr>
<td>Income</td>
<td>below avg. income</td>
<td>above avg. income</td>
<td>above avg. income</td>
<td>below avg. income</td>
<td>average income</td>
</tr>
<tr>
<td>Age</td>
<td>above avg. age</td>
<td>above avg. age</td>
<td>above avg. age</td>
<td>below avg. age</td>
<td>below avg. age</td>
</tr>
<tr>
<td>Other characteristics</td>
<td>use bike as main transportation mode</td>
<td>Status seeker</td>
<td>perceive driving as a functional activity</td>
<td>do not care about ownership (non-possessive)</td>
<td>conservatives (not open to innovativeness)</td>
</tr>
<tr>
<td></td>
<td>tend to adopt innovations when the benefit is &quot;show-off&quot;</td>
<td>present innovations when the benefit is increased efficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size in population</td>
<td>19%</td>
<td>10%</td>
<td>7%</td>
<td>21%</td>
<td>20%</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>High Standard</td>
<td>1.5</td>
<td>2.9</td>
<td>1.0</td>
<td>1.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Walking time</td>
<td>2.2</td>
<td>2.1</td>
<td>2.1</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Availability</td>
<td>2.1</td>
<td>2.1</td>
<td>2.0</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Flexibility</td>
<td>5.0</td>
<td>4.3</td>
<td>2.0</td>
<td>3.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Willingness to pay for staying with the same supplier (loyalty)</td>
<td>0.36</td>
<td>0.38</td>
<td>0.37</td>
<td>0.28</td>
<td>0.22</td>
</tr>
<tr>
<td>Willingness to pay for 1 point higher lifestyle fit</td>
<td>47%</td>
<td>35%</td>
<td>79%</td>
<td>47%</td>
<td>46%</td>
</tr>
</tbody>
</table>

**Initial skills**

This is obtained from the survey results provided by the TAU team.

**Maximum threshold for total costs per unit of need**

There is no estimation that can be done with the current consumer groups, so 100 is assumed so that it won’t make any impact on the results.

We assume no willingness to pay for laziness.

**Return on investment period**

It was agreed to be 136 weeks for modelling reasons.

The rest of the data is either case definition or model assumption. Please note that the number of consumers in the model does not need to be equal to the real number of people in the population, this should be scaled down for practical purposes, and this does not damage the value of the simulation outcomes. What is important is the proportion of Consumer agents compared to the number of Producing Business agents. We keep the total number of Consumers at 1000. The number of Consumers (row 66) has been filled by multiplying the fractions given by the percentages in the TAU table above.
Appendix C: Interview guideline

<table>
<thead>
<tr>
<th>Theme</th>
<th>Example questions</th>
</tr>
</thead>
</table>
| **Understanding of vehicle sharing systems** | How is car-sharing defined?  
What are the existing/potential car-sharing/bike-sharing services in the country?  
What makes it more convenient to choose car-sharing as opposed to public transport and cycling?  
How many car/bike manufacturers and service providers in the selected country? Would you be able to categorize them as small/large companies?  
Are there any patterns between ownership and sharing in different modes? Bike-sharing used by car-owners? Or non-car owners likely to use car-sharing or public transport?  
How often do you change the business models? What influences your decision? How long is your strategic vision? |
| **Market exploration** | What are the relationships between (central/local) governments, manufacturers, and service and infrastructure providers?  
Can you explain the relationships between market research and strategic changes?  
What is the cost of infrastructure (road, electricity, etc.)? |
| **Barriers and potential for uptake** | How do you see the societal perception on vehicle sharing in the selected cities? Does city size matter?  
What are the potential consumer groups? (Income, age, trip purpose, status)  
Any information on travel distance needed by different consumer groups?  
What are consumer preferences – green/trendy/technological?  
What is the perception of public transport users/cyclist on car and bike-sharing?  
Further uptake on bike ownership and bike-sharing?  
Do you think sharing is socially exclusive? |
| **‘Imagined public’ and ‘potential travel markets’** | |
Appendix D: Focus group discussion materials

Conceptual mapping exercise – understanding of vehicle sharing

This exercise is to identify the differences between the understandings of vehicle sharing by users and nonusers (via questions with 2 separate groups)

Start with the nonusers’ group:
- What do you understand by ‘sharing transport’?
- Can you give any specific examples of transport sharing services?
- How many car clubs they can name and if they know of any bike-sharing schemes/docking stations in their respective residential/work/school locations...
- How do you think car-sharing and bike-sharing work?
- Would you join? Why would you join?
- Would you give up your own bicycle/car?
- What information do you need about the schemes before you join?

For users’ group
- What are the options of sharing in transport? How do you think bike-sharing work? How are both schemes different to car rental/car and bicycle ownership?
- Have you ever taken part in a local car-pooling project?
- How did you find out about the schemes?
- Why did you join?
- Did you give up your own car?
- Have you ever used the London Cycle Hire scheme?
- What types of car-sharing models do you know of?
- Gather both groups to ask the users what aspects of their life when they joined the car-sharing schemes.
- Perceived wellbeing: Allow non-users to ask questions to the users – anything they would like to learn about the schemes.
- Ask about their driving/cycling styles... How would you describe yourself as a driver?

SPREE Travel Options Mapping Exercise

The aim of this exercise is to understand the participants’ travel patterns and how and why they would change/changed to vehicle sharing and whether it would change their level of participation in social life. The participants should be given the opportunity to articulate their own views. With this exercise, the accessibility impacts of car- and bike-sharing (in terms of access to transport services and access to education/employment/key social services) will also be identified.

The participants are provided with
- a map that shows the locations of the available services
- a list of key players (car and bike-sharing in the selected city/region)
- information on availability of services (walking distance from their homes)
- information on locations of designated parking areas/docking stations
The exercise should be accompanied by short questions by the moderator to understand the behavioural thresholds for the lifestyles indicators identified in the ABM case definition.

**Inclusive governance and the uptake/social impacts of sharing**

This section is to understand the social justice implications of using car- and bike-sharing. First, the perceived fairness/effectiveness/acceptability is evaluated. The second part focuses on whether participation and transparency in governance increases as a result of both formal and informal schemes.

1. Focus on car- and bicycle-sharing and explore the participants’ understanding of the impacts of the schemes.

Questions to ask:
- Why do you think car clubs exist?
- Why do you think the London Cycle Hire scheme started?
- What do you think are the potential impacts? (Both on individuals and society from economic, social and environmental perspectives?)
- Does the system have an equal impact on everyone? Do you think car-sharing scheme use has a class/gender/age dimension? Who do you think are the main users? Why?
- What do you think is the role of technology in a car-sharing scheme/bike-sharing scheme? Should there be more of it?

a. The main aspects/impacts to understand are whether equal access to political participation improves or the governance becomes more accountable and its impacts on other sectors (integration). The discussion should be embedded within the context of the relationships amongst CarPlus, Transport for London, London Councils, Mayor’s Office, Barclays and the UK Department for Transport. How the impacts change in different geographical regions is also included in the discussion.

b. Transparency of transport governance structure, i.e. level of knowledge required in the uptake of vehicle sharing and its implications

c. Access to decision-making process, i.e. willingness to participate in planning and reaching a consensus on planning and regulation issues

d. Integration with other sectors – any cross-sector impacts on education and industrial policy?

2. Story-telling exercise will be employed to understand the participants’ perceptions on the role of governance and how they are affected by it. The stories will be briefly told by two different moderators 1) BMW buying the online ventures parkatmyhouse 2) Do you think London Cycle Hire a political project?

Before the stories:
- What do you know about the governance of sharing schemes in London/Bristol? Do you think all the information has been made publicly available?
- Who do you think are involved in the London cycle hire/car club?
- Do you know what you are being charged for public transport and sharing schemes?
- Do schemes improve the pricing understanding?

After the stories on parking and bike-sharing in London:
- What do you know about the parking policy in London?
- Do you trust the government/businesses? Should shared parking space be facilitated by governments/businesses in the context of car-sharing? (in the context of BMW buying the app)
- What do you think are the main legal/institutional barriers behind car-sharing and bike-sharing schemes or public transport, cycling and walking in general?
- How do you feel about public transport and walking/cycling facilities in London?

Further uptake

The participants will be asked the following questions:
- Who, in your family/work colleagues/relatives/neighbours, would join a car club/cycle hire scheme? Why?
- Do you think there will be more uptake in London? Why?
- Will you be using more of these services? Or do you think there will be better alternatives?
Appendix E: Consumer survey (Developed in cooperation with TAU)

**SPREE Mobility Questionnaire**

1. *This first section asks basic information about your background.*

**ABOUT YOU…**

| 1. How many people other than yourself are there in your household? |
| --- | --- | --- | --- |
| Adults | 0 | 1 | 2 | or more |
| Children | 0 | 1 | 2 | or more |

2. Your age (in years)

3. Your gender
   - Male
   - Female

4. How do you define your ethnicity?
   - White (English, Welsh, Scottish, Northern Irish, British Irish, Irish Traveller)
   - Black / African / Caribbean / Black British
   - Mixed / multiple ethnic groups (White, Black Caribbean, Black African, White and Asian)
   - Asian / Asian British
   - Other ethnic group (e.g. Arab, other, please describe below)

5. Which of these best describes your situation?
   - At work as employee or employer / self-employed
   - Employed, on child-care leave or other leave
   - Unemployed less than 12 months
   - Unemployed 12 months or more
   - Unable to work due to long-term illness or disability
<table>
<thead>
<tr>
<th>6. Do you currently have a paid job?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Which of these best describes your annual gross household income?</td>
<td>Less than £20,000</td>
<td>£20,000 - £40,000</td>
</tr>
<tr>
<td>8. Please indicate your level of formal education</td>
<td>GCSE (O level) or equivalent</td>
<td>A level or equivalent</td>
</tr>
</tbody>
</table>

2. **The second section is about your transport assets and mobility habits.**

**ABOUT YOUR TRAVEL...**

<table>
<thead>
<tr>
<th>9. Which of the following options would you indicate to be your most common method of travelling in general? (for daily travel)</th>
<th>Private car</th>
<th>Public transport only</th>
<th>Cycling</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Do you know how to ride a bicycle?</td>
<td>Yes</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>11. Do you consider yourself a good bicycle rider?</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither Agree/ or disagree</td>
<td>Disagree</td>
</tr>
<tr>
<td>12. Do you own a bicycle?</td>
<td>Yes</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>13. Do you ride a bicycle on a regular basis?</td>
<td>Yes</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Purpose 1: Commute</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If so how often do you ride?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least once a day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Few times a week</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Few times a month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once or few times a year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How long is your average ride</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 0.5 hour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5 hour – 1 hour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Purpose 2: Leisure

**If so how often do you ride?**

- At least once a day
- Few times a week
- Few times a month
- Once or few times a year
- Other

**How long is your average ride**

- Up to 0.5 hour
- 0.5 hour – 1 hour
- More than 1 hour

**What is average the distance you ride on a trip?**

- Up to 1 mile
- 1 mile – 5 miles
- More than 5 miles

### Purpose 3: Leisure

**If so how often do you ride?**

- At least once a day
<table>
<thead>
<tr>
<th>Purpose 4: Sport</th>
<th>How often do you ride?</th>
<th>How long is your average ride</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At least once a day</td>
<td>Up to 0.5 hour</td>
</tr>
<tr>
<td></td>
<td>Few times a week</td>
<td>0.5 hour – 1 hour</td>
</tr>
<tr>
<td></td>
<td>Few times a month</td>
<td>More than 1 hour</td>
</tr>
<tr>
<td></td>
<td>Once or few times a year</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What is average the distance you ride on a trip?</th>
<th>Purpose 4: Sport</th>
<th>How often do you ride?</th>
<th>How long is your average ride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 1 mile</td>
<td></td>
<td>At least once a day</td>
<td>Up to 0.5 hour</td>
</tr>
<tr>
<td>1 mile – 5 miles</td>
<td></td>
<td>Few times a week</td>
<td>0.5 hour – 1 hour</td>
</tr>
<tr>
<td>More than 5 miles</td>
<td></td>
<td>Few times a month</td>
<td>More than 1 hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Once or few times a year</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>
What is average the distance you ride on a trip?

- Up to 1 mile
- 1 mile – 5 miles
- More than 5 miles

Purpose 5: Other, state which one:

If so how often do you ride?

- At least once a day
- Few times a week
- Few times a month
- Once or few times a year
- Other

How long is your average ride

- Up to 0.5 hour
- 0.5 hour – 1 hour
- More than 1 hour

What is average the distance you ride on a trip?

- Up to 1 mile
- 1 mile – 5 miles
- More than 5 miles

15. How much do you agree with the following statements?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree/ or disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riding a bicycle is healthy and keeps me in shape</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmentally friendly</td>
<td>Riding a bicycle is more cost effective than other transportation modes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle is not possible for me because I need to pass long distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle is a heavy physical effort for me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle it is not safe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle is not a good option because of poor local infrastructure (i.e. bicycle paths)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle as a mean of transportation is impossible because of weather conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle aligns with my social norms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle is mentally relaxing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle is Comfortable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle is time saving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riding a bicycle helps to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# SPREE Project

**SERVICIZING POLICY FOR RESOURCE EFFICIENT ECONOMY**

<table>
<thead>
<tr>
<th>Improve time flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riding a bicycle offers privacy</td>
</tr>
<tr>
<td>Riding a bicycle suits my lifestyle</td>
</tr>
<tr>
<td>Wearing a helmet is important</td>
</tr>
</tbody>
</table>

**Bike-sharing schemes** is a service, in which bicycles are provided for short-term rental between any two docking stations, enabling bicycle usage for point-to-point trips without having to own a bicycle. The average cost of this service is 1 £ per hour and the bike are always in a good condition well maintained.

**16. Do you have a bike-sharing scheme in your neighbourhood?**

- Yes
- No
- Maybe
- Don’t know

**17. If yes, have you ever used it?**

- Frequently
- 1-5 times over the last 5 years
- Not at all

**18. Will you consider using bike-sharing scheme in the future?**

- Yes
- No
- Maybe
- Irrelevant (state why)

**19. How many of the following vehicles are kept in your household?**

- Private cars
- Motorcycles
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. How many cars do you have in your household? 1, 2, 3 or more</td>
<td>Vans, Company cars, None of the above</td>
</tr>
<tr>
<td>21. Do you have a driving license?</td>
<td></td>
</tr>
<tr>
<td>23. Do you intend to buy another car?</td>
<td></td>
</tr>
<tr>
<td>24. Do you intend to buy a car</td>
<td></td>
</tr>
<tr>
<td>25. Do you intend to sell any car that you own in the near future?</td>
<td></td>
</tr>
<tr>
<td>26. We would like to know more about your views on car ownership.</td>
<td>Strongly Agree, Agree, Neither Agree/ or disagree, Disagree, Strongly disagree</td>
</tr>
<tr>
<td>Please indicate whether the following statements are true/false or do not apply to you.</td>
<td></td>
</tr>
<tr>
<td>Not having a car and not considering to buy one in the future</td>
<td></td>
</tr>
<tr>
<td>Not having a car but considering to buy one in the future</td>
<td></td>
</tr>
<tr>
<td>Having a car but... willing to sell it straightway if a car club is made available in the area</td>
<td></td>
</tr>
<tr>
<td>Having 2 or more cars in the household but... considering</td>
<td></td>
</tr>
</tbody>
</table>
In each of the following 6 questions you will be presented with 3 alternatives for car clubs for an inner-city service in London. Each alternative is described by price, car class (standard, high standard, and premium), cost per hour, walking time from your house to the nearest car spot in minutes, and the time required to reserve the car in advance in hours. In each question please choose you preferred option.

Car has to be returned to the same pick-up point. [for half of the respondents as this sentence in yellow]. Assume that bike-sharing service will be available next to each pick-up point as well as access to public transport.

Also:

1) Insurance cover: state minimum liability insurance, comprehensive and collision insurance. They do not provide uninsured, under-insured or personal injury protection insurance.
2) Fuel costs are included in the rates.
3) The car-sharing company is responsible for the long-term maintenance of the vehicle
4) There are one time joining fees of £25.

### 27. Following are 6 cases with different alternatives. Please choose one preferred option from each case

<table>
<thead>
<tr>
<th>Case</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Not interested in any of the car-sharing options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Standard e.g. Hyundai i20, Suzuki Swift, Kia Rio</td>
<td>Premium e.g. Audi A1, MINI Cooper, Citroen DS3</td>
<td></td>
</tr>
<tr>
<td>cost per hour in £</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>walking time from your house to the nearest car spot in minutes</td>
<td>10</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Time required to reserve the car in advance in hours</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>What is your preferred option</td>
<td>alternative 1</td>
<td>alternative 2</td>
<td>Not interested in any of the car-sharing options</td>
</tr>
<tr>
<td>2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car class</td>
<td>High standard e.g. Peugeot 208, Renault Clio, Volkswagen Polo</td>
<td>Premium e.g. Audi A1, MINI Cooper, Citroen DS3</td>
<td></td>
</tr>
<tr>
<td>cost per hour in £</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>walking time from your house to the nearest car spot in minutes</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Time required to reserve the car in advance in hours</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>What is your preferred option</td>
<td>alternative 1</td>
<td>alternative 2</td>
<td>Not interested in any of the car-sharing options</td>
</tr>
<tr>
<td>3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car class</td>
<td>standard e.g. Hyundai i20, Suzuki Swift, Kia Rio</td>
<td>Premium e.g. Audi A1, MINI Cooper</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Citroen DS3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>cost per hour in £</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>walking time from your house to the nearest car spot in minutes</td>
<td>5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Time required to reserve the car in advance in hours</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>What is your preferred option</td>
<td>alternative 1</td>
<td>alternative 2</td>
<td>Not interested in any of the car-sharing options</td>
</tr>
<tr>
<td>car class</td>
<td>High standard e.g. Peugeot 208, Renault Clio, Volkswagen Polo</td>
<td>Premium e.g. Audi A1, MINI Cooper, Citroen DS3</td>
<td></td>
</tr>
<tr>
<td>cost per hour in £</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>walking time from your house to the nearest car spot in minutes</td>
<td>15</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Time required to reserve the car in advance in hours</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>What is your preferred option</td>
<td>alternative 1</td>
<td>alternative 2</td>
<td>Not interested in any of the car-sharing options</td>
</tr>
<tr>
<td>car class</td>
<td>options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premium e.g. Audi A1, MINI Cooper, Citroen DS3</td>
<td>High standard e.g. Peugeot 208, Renault Clio, Volkswagen Polo</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| cost per hour in £ | 5 | 1 |
| walking time from your house to the nearest car spot in minutes | 5 | 15 |
| Time required to reserve the car in advance in hours | 1 | 1 |
| What is your preferred option | alternative 1 | alternative 2 | Not interested in any of the car-sharing options |

6)

<table>
<thead>
<tr>
<th>car class</th>
<th>options</th>
</tr>
</thead>
<tbody>
<tr>
<td>High standard e.g. Peugeot 208, Renault Clio, Volkswagen Polo</td>
<td>Standard e.g. Hyundai i20, Suzuki Swift, Kia Rio</td>
</tr>
</tbody>
</table>

<p>| cost per hour in £ | 5 | 3 |
| walking time from your house to the nearest car spot in minutes | 10 | 10 |</p>
<table>
<thead>
<tr>
<th>Time required to reserve the car in advance in hours</th>
<th>6</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your preferred option</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

28. Please tell us about your annual car costs...

**Vehicle Number 1**

Make and model: ............................................. Age: ....... years

When did you buy it ...............  

How many miles you drive (on average) per year? ............... miles

Can you estimate your annually costs on your vehicle (including gas, insurance and maintenance, depreciation, and license) _________________

**Vehicle Number 2**

Make and model: ............................................. Age: ....... years

When did you buy it ...............  

How many miles you drive (on average) per year? ............... miles

Can you estimate your annually costs on your vehicle (including gas, insurance and maintenance, depreciation, and license) _________________

**Vehicle Number 3**

Make and model: ............................................. Age: ....... years

When did you buy it ...............  

How many miles you drive (on average) per year? ............... miles

Can you estimate your annually costs on your vehicle (including gas, insurance and maintenance, depreciation, and license) _________________

3. The third section is about your local area.
### ABOUT YOUR LOCAL AREA…

29. Please tell us the first three digits of your postal code

<table>
<thead>
<tr>
<th>30. About your neighbourhood</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree/ or disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking is unsafe because of the traffic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycling is unsafe because of the traffic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are no convenient routes for cycling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This area is unsafe because of the level of crime or anti-social behavior.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There is no space to park my car.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There is no space to park my bicycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know the way by public transport to my workplace</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There are good cycling facilities

4. _The fourth section asks you questions regarding your views on mobility-related lifestyle._

**ABOUT YOUR LIFESTYLE AND PERCEPTIONS…**

<table>
<thead>
<tr>
<th>31. <em>Do you count yourself to be…</em></th>
<th>Heavy car user</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average car user</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>28. <em>Do you think you will be able to live without a car? (if applicable)</em></th>
<th>Not at all!</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, please!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only if I get a good alternative</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>29. <em>What is the most important reason for not owning a car? (if applicable)</em></th>
<th>Cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of license and driving incapability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For health reasons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fear of driving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not need a car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For environmental reasons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I don’t like driving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others…</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>30. <em>If you were to give up owning a car what would your most</em></th>
<th>Cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of license and driving incapability</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Important reasons for not owning a car?

<table>
<thead>
<tr>
<th>Reason</th>
<th>For health reasons</th>
<th>Fear of driving</th>
<th>I do not need a car</th>
<th>For environmental reasons</th>
<th>I don't like driving</th>
<th>Others…</th>
</tr>
</thead>
</table>

## 31. Your driving habits and your transport needs...

Indicate whether the following statements about you are true

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree/ or disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving makes my life much easier</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving enables recreational trips and holidays</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car provides protection against bad weather</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car provides privacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I love the drone of my engine and muffler</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The car gives me power in traffic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like driving fast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. How much do you agree with the following statements?</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither Agree/ or disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>----------------</td>
<td>-------</td>
<td>-----------------------------</td>
<td>----------</td>
<td>------------------</td>
</tr>
<tr>
<td>Driving is relaxing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For me, the car has instrumental functions only</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>The car brings me wherever I want</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can choose my own route</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like to drive just for the fun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>We are approaching the limit of the number of people the earth can support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humans have the right to modify the natural environment to suit their needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When humans interfere with nature it often produces disastrous consequences.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human ingenuity will insure that we do NOT make the earth unliveable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humans are severely abusing the environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The earth has plenty of natural resources if we just learn how to develop them</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plants and animals have as much right as humans to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
exist

The balance of nature is strong enough to cope with the impacts of modern industrial nations

Despite our special abilities humans are still subject to the laws of nature

The so-called “ecological crisis” facing humankind has been greatly exaggerated

The earth is like a spaceship with very limited room and resources

Humans were meant to rule over the rest of nature

The balance of nature is very delicate and easily upset

Humans will eventually learn enough about how nature works to be able to control it

If things continue on their present course, we will soon experience a major ecological catastrophe

| 33. | [r1] It says something to people around me when I buy a high priced brand |
|     | [r2] I buy some products because I want to show others that I am wealthy |
|     | [r3] If I had the money, I would be a member of a club for business and professional leaders |
|     | [r4] I would buy an interesting and uncommon version of a product otherwise available with a plain design, to show others that I have original taste |
|     | [r5] Others wish they could have my eye for fashion and good taste |
|     | [r6] By choosing a more exotically designed product, I show my friends that I am different |
### 32. How much do you agree with the following statements

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree/ or Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would buy a product just because it has status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am interested in new products with status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would pay more for a product if it had status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The status of a product is irrelevant to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A product is more valuable to me if it has some snob appeal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 33. How much do you agree with the following statements

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree/ or Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renting or leasing a car is more appealing to me than owning one</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
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<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>I tend to hang on to things I should probably throw out</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get very upset if something is stolen from me, even if it has little monetary value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I don’t get particularly upset when I lose things</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am less likely than most people to lock things up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would rather buy something I need than borrow it from someone else</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I worry about people taking my possessions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I travel I like to take a lot of photographs</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I never discard old pictures or snapshots</td>
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<tr>
<td>r1 I love to use innovations that impress others</td>
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<tr>
<td>r2 I like to own a new product that distinguishes me from others as they don’t own one</td>
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<tr>
<td>r3 I prefer to try new products that I can show to my friends and neighbours</td>
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<tr>
<td>r4 I like to out-do others, and I prefer to do this by buying new products which my friends don’t have</td>
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<tr>
<td>r5 I deliberately buy novelties that are visible to and command respect from others</td>
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<tr>
<td>r6 If or when a new time-saving product is launched, I will buy it straight away</td>
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SPREE Project
SERVICIZING POLICY FOR RESOURCE EFFICIENT ECONOMY

34. Take one service provider you work with for a long period of time (e.g. cellular phone provider). How much do you agree with the following statements

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree/ or Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I say positive things about the service provider to other people</td>
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<tr>
<td>I recommend the service provider to someone who seeks your advice</td>
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<td>I encourage friends and relatives to do business with the service provider</td>
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<tr>
<td>I consider the service provider your first choice to buy services</td>
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<tr>
<td>I do more business with the service provider in the next few years</td>
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<tr>
<td>I take some of your business to a competitor that offers better prices</td>
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<tr>
<td>I continue to do business with the service provider if its prices increase somewhat</td>
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<tr>
<td>I pay a higher price than competitors charge for the benefits you currently receive from the service provider</td>
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<tr>
<td>I switch to a competitor if you experience a problem with the service provider's service</td>
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<tr>
<td>I complain to other customers if you experience a problem with the service provider's service</td>
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<tr>
<td>I complain to external agencies, such as the Better Business Bureau, if you experience a problem with the service provider's service</td>
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<tr>
<td>I complain to the service provider's employees if you experience a problem with the service provider's service</td>
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</tbody>
</table>
## Appendix F: Expert Interview List

<table>
<thead>
<tr>
<th>Type</th>
<th>Organisation</th>
<th>Title/Division</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy expert</td>
<td>Transport for London (TfL)</td>
<td>Strategy and Planning</td>
<td>London</td>
</tr>
<tr>
<td>Academic expert</td>
<td>Transport Research Laboratory (TrL)</td>
<td>Senior Research Fellow</td>
<td>London</td>
</tr>
<tr>
<td>Industry expert</td>
<td>BIXI Bicycle Scheme (BSS)</td>
<td>Founder</td>
<td>Montreal</td>
</tr>
<tr>
<td>Policy expert</td>
<td>Bristol City Council (BCC)</td>
<td>Group Manager - City Transport</td>
<td>Bristol</td>
</tr>
<tr>
<td>Bus company</td>
<td>First Group (FG)</td>
<td>Interim Managing Director</td>
<td>Bristol</td>
</tr>
<tr>
<td>Academic expert</td>
<td>Susan Shaheen (SS)</td>
<td>Expert on bike-sharing</td>
<td>California</td>
</tr>
<tr>
<td>Academic expert</td>
<td>Scott Le Vine (SLV)</td>
<td>Expert on car-sharing</td>
<td>London</td>
</tr>
<tr>
<td>Accreditation</td>
<td>Carplus (CP)</td>
<td>Chief Officer</td>
<td>Leeds</td>
</tr>
<tr>
<td>Car-sharing</td>
<td>Car club operator</td>
<td>Head of Locations</td>
<td>London</td>
</tr>
<tr>
<td>Car-sharing</td>
<td>Car club operator</td>
<td>Head of Business Services</td>
<td>London</td>
</tr>
<tr>
<td>Cycle hire firm</td>
<td>Cycle the City (CtC)</td>
<td>Owner</td>
<td>Bristol</td>
</tr>
<tr>
<td>Car-sharing</td>
<td>City Club (CC)</td>
<td>Managing Director</td>
<td>Bristol</td>
</tr>
<tr>
<td>Policy expert</td>
<td>British Parking Association (BPA)</td>
<td>Director of Policy and Public Affairs</td>
<td>West Sussex</td>
</tr>
</tbody>
</table>

Source: Del 5.1 (Akyelken, et al., 2014)