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Analysis of business opportunities for car-related shared mobility services

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ANALYSIS OF BUSINESS OPPORTUNITIES FOR CAR-RELATED SHARED MOBILITY SERVICES

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ABSTRACT

The confluence of digital technology and connectivity has led, in several sectors, to the rise of application-based shared economy activities. In particular, in the mobility sector, there has been an increase in on-demand shared transport initiatives. These new business models are transforming the urban mobility sector from a limited choice of transport services to a scenario full of new players offering different types of demand responsive mobility services.

This change in urban mobility also has an impact on the automotive industry, where manufacturers such as SEAT not only see the opportunity for their cars to be used by these new services, but begin as well to see themselves as potential providers of mobility services. Even so, for the time being, the most popular and widespread shared mobility services remain unprofitable.

For this reason, the thesis analyses the business models of the new shared mobility services, with the aim of proposing improvements to increase their profitability. It also identifies the different uses that can be given to them and the factors to be taken into account in the design and implementation process.

The methodology used for this research is the study of cases, which have been conducted through surveys and interviews.

The research begins with the study of the current and future mobility ecosystem and the behaviour of the automobile industry in this context. Next, the following five case studies are developed. The first analyses the business models of shared mobility services provided by cars –i.e. carsharing, ridesharing, and ride-hailing services– to find out synergies between them for proposing a combined business model. The second aims to study the mobility patterns of citizens and their intention to use shared mobility services. The third and fourth case studies focus on the identification of design factors and use cases of on-demand shared ride-hailing services. This part of the research looks at these services given their potential when cars are autonomous, and the opportunities that the software they use represents for public transport, with buses that could become demand responsive transport services. Finally, the fifth case study analyses the mobility ecosystem from the perspective of local governments and providers of technology and insurance, studies the feasibility of the combination of uses in shared mobility services, and detects the barriers faced by these new business models.

Keywords: Demand responsive transport, shared mobility services, car sharing, ride hailing, ride sharing, ride sourcing, Mobility as a Service, business model.

RESUM

La confluència de la tecnologia digital i la connectivitat ha motivat, en diversos sectors, l'auge de les activitats d'economia compartida basades en aplicacions. Concretament, en el sector de la mobilitat s'ha experimentat un creixement de les iniciatives de transport compartit a demanda. Aquests nous models de negoci estan transformant el sector de la mobilitat urbana, que passa de tenir una oferta limitada de serveis de transport a un escenari ple de nous actors que ofereixen diferents serveis de mobilitat a la carta.

Aquest canvi en la mobilitat urbana també impacta en la indústria de l'automòbil, on fabricants com SEAT no només veuen l'oportunitat que els seus cotxes siguin utilitzats per aquests nous serveis, sinó que a més a més es comencen a veure com a possibles proveïdors de serveis de mobilitat. Tot i això, de moment, els serveis de mobilitat compartida més populars i estesos continuen sense ser rendibles.

Per aquesta raó, la tesi portada a terme analitza els models de negoci dels nous serveis de mobilitat compartida, amb l'objectiu de proposar millores que permetin augmentar la seva rendibilitat. També s'identifiquen els diferents usos que se'ls hi pot donar i els factors que cal tenir en compte a l'hora de dissenyar-los i implementar-los.

La metodologia utilitzada per a aquesta investigació és l'estudi de casos, els quals s'han desenvolupat a través d'enquestes i entrevistes.

La recerca comença amb l'estudi de l'ecosistema de mobilitat actual i futur, i el comportament de la indústria de l'automòbil en aquest context. Tot seguit es desenvolupen cinc casos d'estudi. En el primer s'analitzen els models de negoci dels serveis de mobilitat compartida que s'ofereixen amb cotxes, és a dir, els serveis de *carsharing*, *ridesharing* i *ride-hailing*, amb la finalitat de trobar sinergies entre ells per a proposar un model de negoci combinat. El segon té com a objectiu estudiar els patrons de mobilitat dels ciutadans i la seva intenció en utilitzar els serveis de mobilitat compartida. El tercer i el quart cas d'estudi se centren a identificar els factors de disseny i els casos d'ús dels serveis d'*on-demand shared ride-hailing*. Aquesta part de la investigació es fixa en aquests serveis pel potencial que poden tenir quan els cotxes siguin autònoms, i per les oportunitats que el software que utilitzen representen per al transport públic, amb busos que podrien convertir-se en serveis de transport a demanda. Per últim, en el cinquè cas d'estudi s'analitza l'ecosistema de mobilitat des de la perspectiva dels governs locals i dels proveïdors de tecnologia i d'assegurances, s'estudia la viabilitat de la combinació d'usos en els serveis de mobilitat compartida, i es detecten quines són les barreres amb què es troben aquests nous models de negoci.

RESUMEN

La confluencia de la tecnología digital y la conectividad ha motivado, en varios sectores, el auge de las actividades de economía compartida basadas en aplicaciones. Concretamente, en el sector de la movilidad se ha experimentado un crecimiento de las iniciativas de transporte compartido a la demanda. Estos nuevos modelos de negocio están transformando el sector de la movilidad urbana, que pasa de tener una oferta limitada de servicios de transporte a un escenario lleno de nuevos actores que ofrecen diferentes servicios de movilidad a la carta.

Este cambio en la movilidad urbana también impacta en la industria del automóvil, donde fabricantes como SEAT no solo ven la oportunidad que sus coches sean utilizados por estos nuevos servicios, sino que además se empiezan a ver como posibles proveedores de servicios de movilidad. Aun así, por el momento, los servicios de movilidad compartida más populares y extendidos continúan sin ser rentables.

Por esta razón, la tesis llevada a cabo analiza los modelos de negocio de los nuevos servicios de movilidad compartida, con el objetivo de proponer mejoras que permitan aumentar su rentabilidad. También se identifican los diferentes usos que se les puede dar y los factores a tener en cuenta en el proceso de diseño e implementación.

La metodología utilizada para esta investigación es el estudio de casos, los cuales se han desarrollado por medio de encuestas y entrevistas.

La investigación empieza con el estudio del ecosistema de movilidad actual y futuro, y el comportamiento de la industria del automóvil en este contexto. Posteriormente se desarrollan cinco casos de estudio. En el primero se analizan los modelos de negocio de los servicios de movilidad compartida que se ofrecen con coches, es decir, los servicios de *carsharing*, *ridesharing* y *ride-hailing*, con el fin de encontrar sinergias entre ellos para proponer un modelo de negocio combinado. El segundo tiene como objetivo estudiar los patrones de movilidad de los ciudadanos y su intención al utilizar los servicios de movilidad compartida. El tercer y el cuarto caso de estudio se centran en identificar los factores de diseño y los casos de uso de los servicios de *on-demand shared ride-hailing*. Esta parte de la investigación se centra en estos servicios por su potencial con la llegada del coche autónomo, y por las oportunidades que el software que utilizan representan para el transporte público, con autobuses que podrían convertirse en servicios de transporte a la demanda. Por último, en el quinto caso de estudio se analiza el ecosistema de movilidad desde la perspectiva de los gobiernos locales y de los proveedores de tecnología y seguros, se estudia la viabilidad de la combinación de usos en los servicios de movilidad compartida, y se detectan cuáles son las barreras para estos nuevos modelos de negocio.

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Three and a half years ago I decided to change direction in my career and undertake the industrial doctorate that I present in the following pages, which meant joining a large multinational company and dive into an emerging area of knowledge. For this great opportunity I would like to thank the Secretariat of Universities and Research of Generalitat de Catalunya, as promoter of the Industrial Doctorates Plan, as well as SEAT S.A. and Universitat Politècnica de Catalunya for having trusted me to pursue this dissertation research project. I am also very thankful to CARNET and MOIA for their involvement in this investigation, which has been essential for conducting two case studies.

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AMB	Metropolitan Area of Barcelona *(Àrea Metropolitana de Barcelona)*
App-based	Requested through mobile applications
B2B	Business-to-Business
B2C	Business-to-Consumer
BMC	Business Model Canvas
DRT	Demand Responsive Transportation
ETA	Estimated Time of Arrival
ICT	Information and Communication Technologies
ID	Digital Identity
MaaS	Mobility as a Service
OEM	Original Equipment Manufacturer
P2P	Peer-to-Peer
PT	Public Transport
RMB	Metropolitan Region of Barcelona *(Regió Metropolitana de Barcelona)*
RQ	Research Question
TNC	Transportation Network Company
VTC	Chauffeured Tourism Vehicle *(Véhicule de Tourisme avec Chauffeur)*

Chapter 1. INTRODUCTION

The trend towards a more sustainable urban mobility is growing since both governments and citizens are giving more importance, day by day, to the environmental problems caused by urban mobility. At the same time, new transport means such as on-demand shared mobility services requested through mobile applications (app-based), which are expected to contribute to more sustainable mobility by motivating people to renounce their private cars, are becoming more popular. Thus, when one does not have the availability of either a private car or public transport that adequately satisfies mobility needs, there exists the alternative of new mobility services, such as carsharing (renting a car by the hour or minute) and ride-sourcing (taking a ride in a shared vehicle). However, there might also be a risk that these services grow out of control and end up overloading cities.

These emerging business models are generated, on the one hand, by technology (some already existed, but now, being app-based, are achieving success), and on the other, depending on the actions of the public administration, which cause that the same service in different cities may operate differently. Regulation is a key factor in the characterisation of these new business models, which in addition to being different among countries, regions, and cities is nowadays in constant change, adapting to the corresponding reality in the different locations and times. Another circumstance with a direct and significant effect on the business models will be the full use of autonomous vehicles for the provision of mobility services. Although these factors are fairly uncontrollable and unpredictable, this thesis identifies certain trends in how they impact business models, and the opportunities and limitations that arise from them. Apart from that, this dissertation includes several case studies with potential users of shared mobility services to identify their requirements and expectations.

This chapter begins with the identification of the problem and the research questions. Then, the objectives and hypotheses of the research are exposed. To close, an introduction to the research methodology used is presented.

1.1 PROBLEM STATEMENT AND RESEARCH QUESTIONS

Social and economic trends have strongly changed in the last years due to the economic crisis and the evolution of technology. These factors have influenced a sharing revolution, also in the mobility sector, motivated for the increasing urbanisation and environmental consciousness. The growing urbanisation and its related urban traffic is causing air quality in many cities to be poor. Thus, cities all over the world are starting to implement driving restrictions to reduce pollution and improve their air quality.

But public transport alone cannot cover all inhabitants' mobility needs. Therefore, sustainable mobility services complementary to public transport are key to get people to travel less in private vehicles.

In the last few years, from the identification of this business opportunity –to provide flexible and sustainable shared mobility services–, many new transport providers emerged and are now expanding their services worldwide. Although few providers of on-demand shared mobility services have profits (Perboli et al., 2018), they are growing fast (Cohen & Kietzmann, 2014; Ross, 2015; Bouton et al., 2015; Frost & Sullivan, 2016b), and in some cities, in an unregulated and uncontrolled way, as already mentioned. Some of these services are already widely spread, such as the ride-hailings Uber[1] and Lyft[2] (similar to the taxi service, with the difference that pick up street hails are not authorised without a previous booking), or the carsharings car2go[3] and Zipcar[4]. Others cannot afford their losses and they have to shut down, such as the shared ride-hailing service Chariot (Marshall, 2019).

In this context, car manufacturers –including SEAT, company in which the present research has been conducted– have detected that these services may affect their core business: the sale of cars to private customers. However, car-related mobility services do require cars to operate. Consequently, in view of the potential expiry of their current business models, automakers are investing, acquiring, and partnering emerging shared mobility services, or even creating their own. And, in this way, they are shaping their own mobility platforms and alliances.

For these services to be successful (i.e. to earn and maintain customer loyalty, and achieve a high use rate), they will have to be perceived as being the best option for consumers at all times. But what does this mean? Users value very positively having a single point to search among available services, and where to book and pay for them (Sochor et al., 2015; Marinic & Vanobberghen, 2016). Therefore, it makes sense to think about unified services, mobility alliances, and even in subscription plans and loyalty programs. Predictably, some decision factors such as the cost, trust, and convenience should be taken into consideration in the service design. But what other aspects also have to be considered? And how important are they and for what type of users?

To the best of our knowledge, the research undertaken until now regarding these new emerging mobility services, from a business perspective, was mainly focused on the benefits and implications for society. In addition, previous studies reflected the importance of the collaboration between service operators and local governments, among other partnerships (Firnkorn & Müller, 2012; Cohen & Kietzmann, 2014; Le Vine, 2014; Kannstätter & Meerschiff, 2015; Herrador et al., 2015; Watanabe et al., 2017; Janasz & Schneidewind, 2017). However, a deeper research addressing these services in the fields of business and service design is required to advance in the definition of new business opportunities and strategies for car manufacturers in this growing, but uncertain sector.

Within the new urban mobility landscape, this study will focus on the services provided by cars –micro-mobility business models (i.e. scooter sharing, bike sharing and kick scooter sharing) will not be considered in the research–. Automakers are investing millions of euros and dollars in creating,

[1] For more info, see: https://www.uber.com
[2] For more info, see: https://www.lyft.com
[3] For more info, see: https://www.car2go.com
[4] For more info, see: https://www.zipcar.com

partnering, and buying mobility services, having in mind that at some point, they might make more money selling mobility instead of cars.

Based on the problem statement presented and with the aim of finding promising business opportunities for the automotive industry in the shared mobility services area, the main Research Question (RQ) of this dissertation is:

- *How could car manufacturers establish a profitable business in the mobility services sector?*

To answer this main question, the following four specific sub-questions are defined:

RQ1: How could car-related shared mobility services evolve to be more cost-efficient?

RQ2: What use cases do car-related shared mobility services have?

RQ3: How are potential users of car-related shared mobility services?

RQ4: What are the user requirements for a frequent use of shared ride-hailing services?

Last but not least, this research cannot forget about new automotive trends that might help to strengthen automakers opportunities in the mobility services market, such as vehicle electrification, digitalisation and the value of data, and the arrival of autonomous vehicles.

1.2 OBJECTIVES

The main purpose of this thesis is to identify innovative business opportunities that enable car manufacturers to profitably implement mobility services. To address this aim, the research is divided in more concrete goals, which are as follows:

1) *Find out synergies between the different app-based car-related shared mobility services that foster the development of new business models, to increase the profitability of these services.*
   At present, most services providers offer the different mobility services separately, without optimising costly resources or activities, such as vehicles or technology.
   This first objective aims to partially answer the research sub-question 1.

2) *Identify use cases and potential customers of car-related shared mobility services.*
   App-based on-demand shared mobility services provide more use cases than other more traditional services, such as rental cars or taxis. However, inhabitants are more reluctant to use these emerging transport modes.
   This second objective is addressed to partially answer the research sub-questions 2 and 3.

3) *Detect the main factors that should be taken into account for the service design of shared ride-hailing transportation from users' perspective.*
   Like other services, shared ride-hailing services should meet users' needs to be successful (i.e. to achieve a high occupancy and utilisation rate). And these user requirements might depend on the type of user and the case of use.

This third aim is intended to answer the research sub-questions 4, and partly answer sub-questions 2 and 3.

4) *Analyse the current mobility ecosystem to identify both business opportunities and barriers.* The business models of shared mobility services depend on the actions of regulators as well as those of other players in the ecosystem, such as technology and insurance providers.
   This fourth goal is aimed at partly answering the research sub-questions 1.

The research is based on the following two hypotheses:

- Car-related shared mobility services have common design factors that could enable the definition of an aggregated business model.
- Autonomous cars are predicted to make carsharing services identical to private ride-hailing, which is also expected to happen with the services of shared ride-hailing and ridesharing. Thus, the design factors to be studied are those of ride-hailing services.

To get the full picture of the entire ecosystem, a significant part of this research is centered on the city of Barcelona, for being one of the most populated and densest cities in Europe, and like many of these municipalities, has a major traffic and pollution problem despite having an extensive public transport. However, to not limit the research to the state of the art of this city, the review of the underlying literature takes on a global scope with a focus on Europe. To this end, a case study is also conducted in another European municipality. The selected one is Hanover, for hosting the first European shared ride-hailing service with city wide coverage.

In particular, this research consists of five case studies, presented in chapters 3 to 6 (Table 1). The first case study aims to study the business models of for-profit car-related shared mobility services, and to identify the activities and resources they could share to improve their profitability. The next three case studies are planned to find out when residents would use these on-demand shared mobility services and what features they should have from the point of view of potential customers. Whereas the fifth case study is designed to examine the perspectives of other key stakeholders in the mobility ecosystem and assess different business opportunities.

Table 1 relates all case studies conducted to the research question or questions that each of them investigates and the chapter of the thesis in which they are explained. The main research question (*How could car manufacturers establish a profitable business in the mobility services sector?)* will be answered at the end of the five cases.

Table 1. Relation of the case studies to the research questions and chapters.

<table>
<tr><th>Case study number</th><th colspan="2">Case study title</th><th>Research question answered</th><th>Chapter number</th></tr>
<tr><td>1</td><td colspan="2">Analysis of app-based car-related shared mobility business models from an integrated perspective</td><td>How could car-related shared mobility services evolve to be more cost-efficient?</td><td>3</td></tr>
<tr><td>2</td><td colspan="2">Analysis of mobility patterns and intended use of shared mobility services in the Barcelona region</td><td>What use cases do car-related shared mobility services have?
How are potential users of car-related shared mobility services?</td><td>4</td></tr>
<tr><td>3</td><td rowspan="2">Mapping of service deployment use cases and user requirements for on-demand shared ride-hailing services</td><td>Barcelona's commuting pilot case study</td><td rowspan="2">What use cases do car-related shared mobility services have?
How are potential users of car-related shared mobility services?
What are the user requirements for a frequent use of shared ride-hailing services?</td><td>5.2</td></tr>
<tr><td>4</td><td>MOIA test service case study</td><td>5.3</td></tr>
<tr><td>5</td><td colspan="2">Analysis of the current and upcoming mobility ecosystem from the perspective of key stakeholders</td><td>How could car-related shared mobility services evolve to be more cost-efficient?</td><td>6</td></tr>
</table>

1.3 Introduction to the Research Methodology

Given the exploratory nature of this thesis, the methodology selected is the case study research (Yin, 2014). Shared mobility services are still unknown to many inhabitants, therefore, this methodology enables us to conduct various consecutive studies, adapting the design of each case study according to the results of the previous one.

Case study research stands out for being a flexible methodology, which *"can address a wide range of questions that ask why, what, and how of an issue and assist researchers to explore, explain, describe, evaluate, and theorize about complex issues in context"* (Harrison et al., 2017, p. 15). Concretely, this methodology is described as *"an empirical inquiry that investigates a phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident"* (Yin, 2014, p. 16).

In addition, the case study research is used in situations where multiple sources of evidence are required (Yin, 2014), which makes this methodology well suited for our research, as it combines quantitative and qualitative results.

The complete methodological procedure is presented in Figure 1. As shown in Figure 1, the research starts defining the problem statement, and then, determining the research questions, the objectives and hypotheses, and the research methodology. Next, to contextualise the fast-changing mobility ecosystem, a literature review within the mobility ecosystem framework is conducted. Due to the fact that the research topic of the thesis is very recent and in constant evolution, few academic papers are available. Therefore, we complement the analysis of the academic literature with grey papers. In addition to this first review of the literature to contextualise the framework, most of the case studies developed include a literature review focused on the concerned studies. In total, we conduct five consecutive studies, and the results of each study are taken as a reference for the next one.

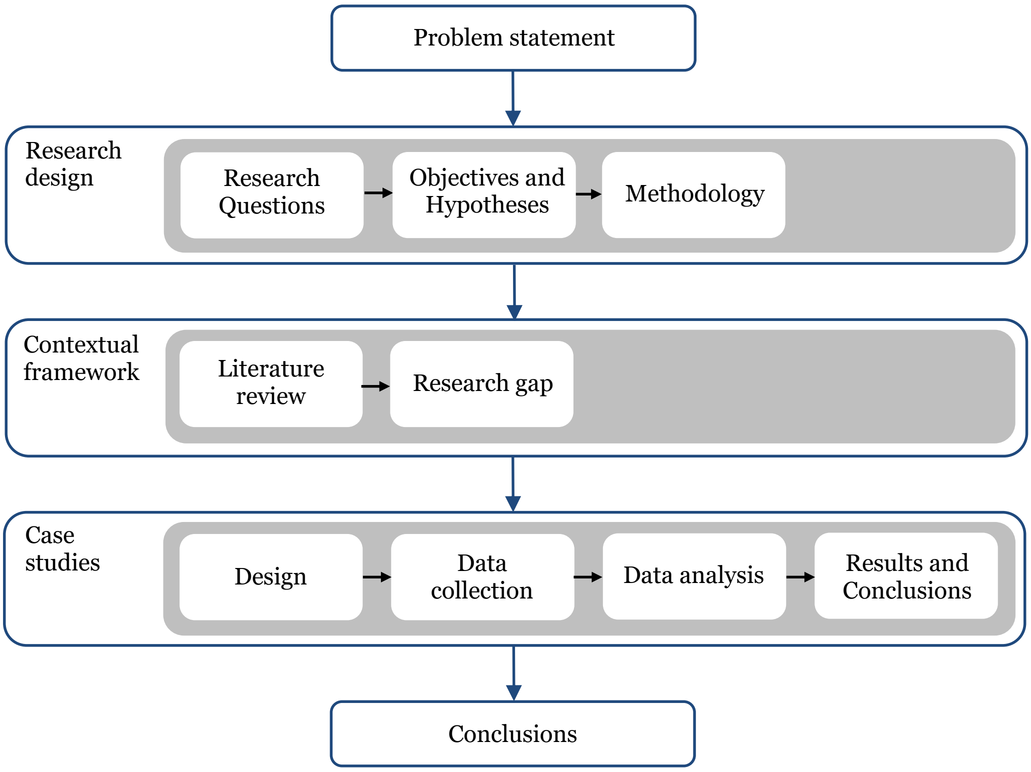


Figure 1. Methodological phases of the research.

Each chapter of this thesis describes in more detail the methodology applied for the particular case study or studies included in that chapter.

Chapter 2. CONTEXTUAL FRAMEWORK

With the objective of understanding the present and the future of the mobility sector, this section begins providing a review of the trends that are influencing a change in the users' habits and behaviours and, as a result, a change in the automotive industry as well. Then, it continues analysing the current mobility ecosystem and its expected immediate future. Finally, a classification of for-profit car-related shared mobility business models –carsharing, ridesharing, and ride-hailing– is provided.

2.1 Global Trends challenging the Mobility Sector and the Automotive Industry

Top worldwide trends like the sharing economy and digitalisation have disrupted many and diverse sectors, such as hotel, banking, music, and telecommunications, and now are contributing to change the urban mobility sector. Sharing economy services are rising thanks to Internet and mobile technology (facilitators of Peer-to-Peer (P2P) platforms), and to new players knowing more about technology than the business activity in which they establish themselves, and which are becoming stronger than lifelong existing businesses. For instance, the change in the mobility sector was not started by traditional actors of the transportation services sector, but by new players such as Uber and Lyft, which saw the opportunity of creating on-demand transportation as a complement to the traditional urban mobility system.

Emerging business models based on the shared economy and on mobile applications seem to have clear benefits, the most important being the job creation with the particularity of the flexibility offered to their workers, which are able to carry out their jobs at their convenience (Penn & Wihbey, 2016). But critics denounce these activities as being of self-interest rather than being based on the shared economy (Schor, 2014). Conversely, taking the case of Uber, it appears that its drivers are even better paid than taxi drivers and chauffeurs (Hall & Krueger, 2015). Hall & Krueger (2015) noted that, unlike taxi drivers, Uber drivers are rated by their customers and have economic incentives in return for good performances. Nevertheless, new businesses based on the sharing economy lack adequate regulation, since the existing regulations for the traditional Business-to-Business (B2B) and Business-to-Consumer (B2C) markets do not always cover the new scenarios Consumer-to-Consumer, also known as P2P, or new B2C activities (Goudin, 2016; Ranchordás, 2015). At European level, the European Parliament stated in 2016 that the current legal framework did not enable a level playing field for the shared economy, and to achieve its full economic potential –estimated at 572 billion euros in annual consumption across the EU-28– some actions had to be carried out (Goudin, 2016).

On the other hand, Morozov (2016) recalled that companies such as Google, Facebook, Uber or Airbnb, which at first glance seem merely intermediaries, are more than just platforms, since they record and analyse our data from which they can even obtain more benefits than from what we pay them directly, monetarily or by viewing their advertisements. Thanks to our data, they are not only quickly progressing to developing Artificial Intelligence, but also clustering an inestimable economic and political power.

In the urban transport sector, the emergence of shared mobility services is also motivated by the increasing urbanisation and environmental consciousness. More than half of the world's population lives in urban areas, a proportion that could increase to 68% by 2050; additionally, the world is projected to have 43 megacities with more than 10 million inhabitants by 2030 (United Nations, 2018). According to this study, Europe is already highly urbanised, with 74% of its population living today in urban regions.

The increase of urbanisation is associated with a rise of urban traffic and, therefore, with a growth of environmental and health problems. Even though the relationship between the rise of urbanisation and the rise of vehicles is not 1:1, the impact of more vehicles in an urban area without changes of infrastructure produces the reduction in speed and, therefore, serious problems of congestion, which further increases time spent in traffic and CO_2 emissions (Wendell Cox, 2003). In 2014, U.S. traffic congestion caused a waste of more than 11.73 billion litres of fuel, a delay of 6.9 billion hours, and a total cost of $160 billion, which could reach to $192 billion by 2020 (Schrank et al., 2015). Also, the European Environment Agency (2016) pointed out that air-pollution, particularly in urban areas, was responsible for 29,980 early deaths per year in Spain and for 520,000 in the EU-28.

To address the issue of urban traffic and its associated problems, driving restrictions are becoming more common. Big cities such as São Paulo, Mexico City and Santiago de Chile started regulating the circulation of vehicles within the city more than 20 years ago. In Spain, the city of Barcelona restricts, since December 2017, the circulation of the most polluting vehicles on days of high levels of contamination, and announced a permanent restriction from 1 December 2019; whilst central Madrid has a similar access regulation since February 2016 and plans to become a zero emission zone by 2025 (European Union & Sadler Consultants, 2019; Ayuntamiento de Madrid, 2016).

Meanwhile, cities are becoming smart cities whilst vehicles are being connected. On one hand, real-time monitoring of roads provides data of traffic, congestion, and pollution, which for example enables smart technology to manage public lighting and react to traffic congestion (The Economist, 2016; Zhuhadar et al., 2017). The Economist (2016) stated that cities are underusing the amount of information already available (e.g. from geospatial and mobile phone data), which could improve the management of city services such as transportation, and help cities grow and develop in a more sustainable way. According to Giffinger et al. (2007), one characteristic of a smart city is its smart mobility. In this area, the new on-demand and shared transportation services are seen as an opportunity to help cities to solve their transportation issues easier and faster.

On the other hand, increased in-car connectivity, Internet of Things applications, connectivity to networks, and the ability to process the generated data are bringing added-value services to both customers and cities and enable the opening of new business opportunities (McKinsey&Company & Bloomberg New Energy Finance, 2016). According to the mentioned study, data privacy is not particularly a problematic question for people, 76% approving to send data to automakers. This is specially positive for manufacturers, which, among other possibilities, will be able to better know their customers and increase satisfaction, as well as implement services with direct benefits for automakers, such as remote diagnosis (GSMA, 2012). Furthermore, data generated by these vehicles will also be worthwhile to cities and other industries, like mobile operators and insurers (SBD, 2012).

Baker et al. (2016) forecasted that the revenues of in-car connectivity and autonomous driving services would increase from $52.5 billion in 2017 to $155.9 billion in 2022, being the safety features the ones with a biggest market share (37%), followed by autonomous driving assistance with 35%. Vehicles with semi-autonomous driving systems restricted to certain circumstances are starting to come on the market and completely autonomous vehicles could be on road in the early 2020s (UITP, 2017; Baker et al., 2016; Bouton et al., 2015; Yeomans, 2014; Morgan Stanley, 2013). According to the authors, this evolution should make driving safer and help to improve urban mobility.

The evolution of the automotive industry towards the shared, connected and autonomous vehicles brings new opportunities and more business initiatives within a foreseeable future. It is believed that self-driving will encourage new vehicle-sharing initiatives, like robo-taxi services –already being tested by some ride-hailing providers such as Uber and Lyft (Wakabayashi & Conger, 2018; Lynley, 2018)– and autonomous shuttles, which already operate in some cities around the world –for the moment along small distances–, provided by new manufacturer companies such as EasyMile[5] and Navya[6]. In addition, the adoption of autonomous vehicles can bring numerous advantages to society, such as the reduction of accidents caused by driver errors. Morgan Stanley (2013) predicted the following potential cost savings for the USA: $488 billion from accident avoidance, $507 billion from the increase in productivity of autonomous cars, $158 billion from fuel savings, and $138 billion plus $11 billion thanks to congestion avoidance, from productivity gain and fuel savings respectively. However, before the penetration of self-driving vehicles on our roads, the laws to regulate the new scenario have to be prepared: traffic rules, the regulatory framework, and driving education and licensing will need to be adapted; technical standardisation for international compatibility and interoperability will have to be developed; and data privacy, cyber security, and liability issues have to be deeply studied and clarified (Pillath, 2016).

In summary, evidence suggests that cars will rapidly evolve from traditional transport modes to sustainable high tech self-driving devices, opening the automotive ecosystem to powerful non-traditional players. To face this revolution, automakers are not only rapidly exploring and launching different transportation services, but also highly investing in connectivity and in electro- and autonomous mobility.

Focusing on the mobility services sector, although some services already exist for a few years now, there is currently a boom in all the most important cities of the world. Automakers and other traditional businesses such as insurance and car rental companies are investing, acquiring, and partnering emerging mobility services, or even creating their own, as well as their own mobility

[5] For more info, see: http://www.easymile.com
[6] For more info, see: https://navya.tech

platforms and alliances. The acquisitions of the carsharing companies Zipcar and the former Bluemove (from January 2019 called Ubeeqo[7]) by Avis and Europcar respectively (Europcar, 2016; Zipcar, 2013) prove that rent-a-car companies are also evolving to on-demand shared mobility services.

The actions of the automobile manufacturer Daimler in creating a comprehensive portfolio of mobility services are worth noting. Daimler launched the carsharing services of car2go and Croove in 2008 and 2017 respectively, and the mobility platform moovel[8] in 2012 (Daimler, 2017). In parallel, it invested in the singular ride-hailing service Blacklane[9] in 2013, it acquired the taxi-hailing services mytaxi[10] and Hailo in 2014 and 2016 respectively, and set up a joint venture with the shared ride-hailing Via[11] in 2017 (Kahn, 2016; Nicola, 2016; Daimler, 2018). Lastly, at the beginning of 2019, Daimler started a cooperation with its competitor BMW, to consolidate the above-mentioned services by unifying them with those of BMW (Daimler, 2019).

Given that public transport does not cover anywhere the totality of travellers' needs, and in big cities, neither does private transport nor the combination of both, emerging on-demand shared and sustainable mobility services, such as carsharing and ride-sourcing, are stepping in to fill this gap, transforming the sector from a scheduled and static system into an on-demand flexible system.

2.2 Current Mobility Ecosystem and Future Trends

Unclear topics such as how long will the transition process take from the introduction of the first self-driving cars until the extinction of all non-fully autonomous vehicles, and how this scenario is foreseen, are not an obstacle for companies aiming to offer shared mobility services, since the competition in this area is growing every passing day. Although a number of these mobility services are economically unviable, their providers are gradually making inroads into the market whilst they improve their services and wait for the moment when they will turn profitable, which should happen when drivers would be no longer needed and human help could be reduced.

According to UITP (2017), a better, sustainable, and equity urban mobility will only be achieved if fleets of shared autonomous vehicles (robo-taxis, on-demand shuttles, car-sharing vehicles, etc.) integrate with public transport services, since competing with public transport would only lead to less efficiency. UITP (2017) also pointed out that this would be the only way to reinforce the public transport network to the point of covering all inhabitants' mobility needs with at least 80% fewer cars. Consequently, the automotive sector is expected to dramatically change. As a matter of fact, the sector is already expecting this mobility tsunami and, therefore, is exploring new business models in the mobility on-demand sector.

[7] For more info, see: https://global.ubeeqo.com
[8] For more info, see: https://www.moovel.com
[9] For more info, see: https://www.blacklane.com
[10] For more info, see: https://mytaxi.com
[11] For more info, see: https://ridewithvia.com

2.2.1 From traditional transportation to the MaaS revolution

Until a few years ago, the offer of transport services that could be found in any city was limited. In each city we could find similar services: bus, tram, underground, train, and taxi, mainly operated by different local companies. This situation is changing and some cities are closer than others to a close future full of local, global, public, and private providers, offering both traditional and new transport services. Whilst some cities are reacting to the uncontrolled expansion of on-demand transportation services, such as London, trying to ban the ride-hailing services of Uber, or New York, announcing restrictions on the number of vehicles providing ride-hailing services (Goldman, 2017), other are partnering with them to widen the offer of transportation services at night, in remote areas, or in areas where the infrastructure is poor, among other reasons (Reich, 2019; Porta, 2018; Morozov, 2016).

Previous studies conducted by Alonso-Mora et al. (2017), Yu et al. (2017), Marinic & Vanobberghen, (2016), Zhang et al. (2015), Martínez et al. (2015), Sochor et al. (2015), and Hampshire & Gaites (2011) analysed the implications, consequences, and benefits of the rise of car-related shared mobility services. Among them, simulations using static, flexible or even real-time routing, service offer, and user demand have been conducted. Particularly, Martínez et al. (2015) stated that in mid-sized European cities like Lisbon, the same mobility could be achieved with the 10% of cars if rides were shared, together with a high-capacity public transport; Alonso-Mora et al. (2017) concluded that 98% of the taxi demand in New York could be covered using 2,000 vehicles with capacity for 10 people or 3,000 with capacity for 4 people, which was, respectively, 15% and 22% of the current taxi fleet; and Yu et al. (2017) estimated that in one year of sharing all the rides in Beijing there would be direct energy savings, a reduction of 46.2 thousand tons of CO_2 emissions, and 235.7 tons of NOx emissions. This way, the authors verified that large-scale shared ride-sourcing is more efficient and sustainable than the current chauffeur services, which usually carry 1 person per trip, while ride-sourcing serves multiple rides (up to the vehicle's capacity) with a single trip and minimised de-routing. On the other hand, carsharing offers cities the possibility of reducing their total number of vehicles, which spend more than 90% of their lives parked on the streets, and it exchanges the vehicles in use for more sustainable ones (Zhang et al., 2015).

However, it seems that the formula to better solve urban traffic problems and their consequences is not any concrete service, but the integration of all of them. Creating integrated, interoperable, coordinated, and multimodal mobility solutions, involving public and private operators, data providers and developers, and local and national governments is essential for a proper and sustainable operation of Mobility as a Service (MaaS) and is seen by users as desirable and convenient (Chan & Shaheen, 2012; Sochor et al., 2015; Marinic & Vanobberghen, 2016; Ambrosino et al., 2016; Kamargianni & Matyas, 2017). Hietanen (2017) sustained that the market would evolve into one of the three options illustrated in Figure 2: either only one integrator assembled the different urban mobility services, and therefore, took all the market and positions itself as the winner; or current public transportation expanded their services offer and included new mobility options; or different aggregators coexisted offering each of them similar services from the same or different providers.

Likewise, a situation could arise where the second and third options coexist, or even another scenario still not contemplated.

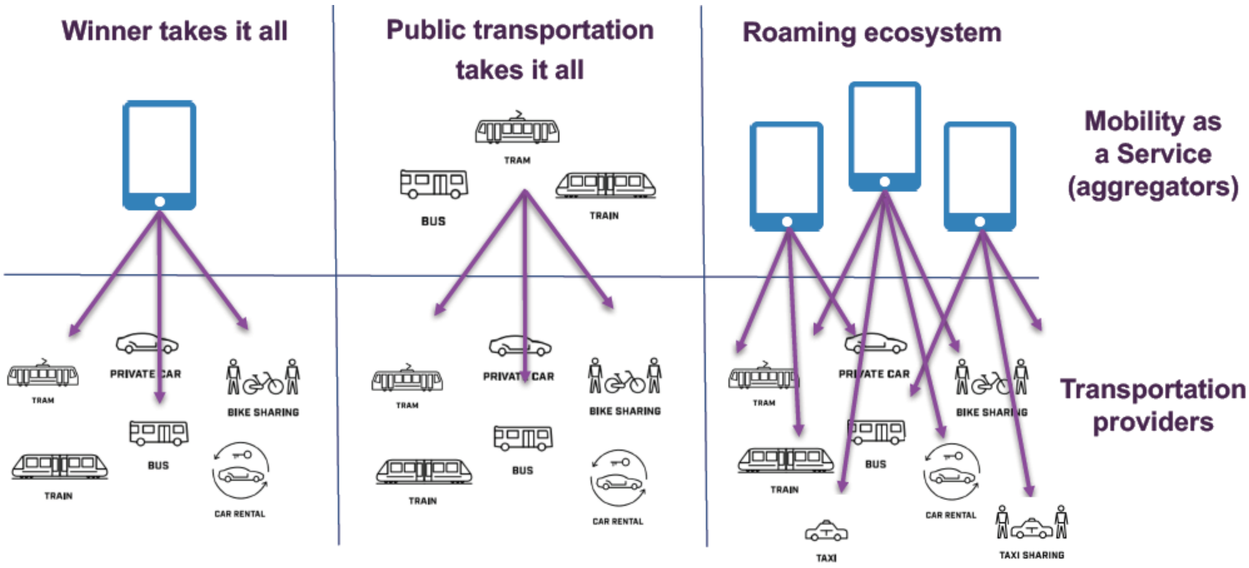


Figure 2. Three ways for markets to evolve (Hietanen, 2017).

Transportation as a Service or MaaS is defined as the unification of all means of travel, this is to say, the combination of different transportation services offered from public and private transportation providers (i.e. the traditional train, bus, underground, or taxi to the more innovative bike sharing, ride-sourcing, or carsharing services) into a single mobile service accessible on-demand to always offer the best option to cover people's travel needs (MaaS Alliance, 2016; MaaS Global, 2016). It should be added that the concept of MaaS is not limited to travellers, since it could also offer goods mobility solutions. Also, MaaS enables a user-centric, sustainable, smart, and seamless mobility, removing user-related pain points such as the need of buying a ticket for each transport mode, and consequently, offering users advanced travel experiences (Kamargianni & Matyas, 2017). According to the authors, MaaS could operate across different cities at an international level, covering the roaming of the transport sector and avoiding the big pain point of having to download and register for a different app for each city we visit.

Some MaaS solutions have already been implemented, such as the Finnish Whim[12] launched by MaaS Global and the German moovel. Transport Systems Catapult (2016) considered that MaaS could change not only the transport sector, since transport operators could keep to being suppliers of MaaS providers, but also users' travel behaviour. In effect, very early findings of Whim based on user data and surveys affirmed that their users increased the rides with taxi (2 to 12 taxi trips per month were included in subscription packages) and some users also increased the usage of rental cars (packages included up to 6 days of car rental per month), although they said that if free parking in the city centre or reduced price deals would have been an option, they would have used more the car rental offer (Hietanen, 2017). On the other hand, the study did not observe changes neither in the usage of public

[12] For more info, see: https://whimapp.com

transport nor in the cycling or walking habits, but found out a slight decrease in the usage of private vehicles.

Hietanen (2016) declared in a private interview that MaaS is redefining the transportation market (which is some trillions a year) such as Google did to media and Netflix to TV, and that there will be winners and losers as always happens with these large transformations. According to Hietanen (2016), the key to success is accepting that one alone cannot provide all services and being open to provide *"the most pluggable open platforms that can be shared with others"*, comparable in the telecommunications sector to Apple, provider of an ecosystem whereby third parties can provide the applications that customers' request and need. Hietanen (2016) also highlighted that another key issue in providing MaaS is the seamless user experience, to give maximum convenience and a surprising and distinctive effect.

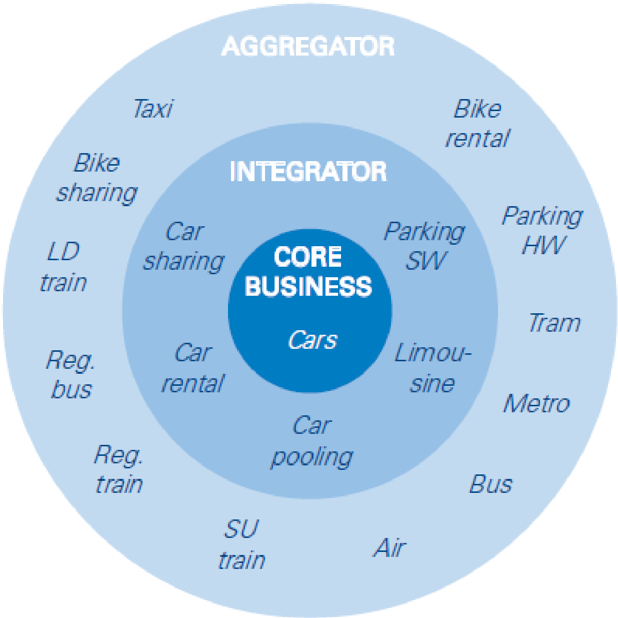
2.2.2 From single services to business ecosystems

Urban residents have begun to change their mobility behaviour, first replacing the typical question of *"Which vehicle should I buy?"* with *"Should I buy a vehicle if I can rent it or share it?"*, until reaching the point, in a near future, where the question becomes an everyday choice: *"Which mobility service fits better my needs of today?"* (Hein, 2012). Considering the shift of consumer preferences towards connected and multimodal mobility, the creation of business ecosystems could be the key to monetise these trends (McKinsey&Company, 2015).

Van Audenhove et al. (2014) identified three long-term sustainable business model archetypes for the future of urban mobility based on the business models of Amazon, Apple, and Dell, which applied to mobility, Amazon depicted the one-stop-shop concept, or in other words, the aggregator of third party services with a single point of access for information, planning, booking, and payment (e.g. MaaS solutions such as moovel or SMILE[13]); the Apple model would be the integrator of own services, meaning the integration of different mobility solutions under one strong brand providing a completely seamless user experience (e.g. the international private public transport operator Transdev, offering 13 different modes of transportation (Transdev, 2017)); and the Dell of mobility represented the single mode specialists (i.e. the stand-alone mobility services). In addition, the authors stated that the Amazon and Apple archetypes could be combined, this way enabling bigger mobility providers with the advantages of both models. Figure 3 illustrates the combination of both models from the perspective of an automotive Original Equipment Manufacturer (OEM), which its core business is the car manufacturing activity. In comparison with the computer technology company Dell, automakers are adopting a similar business model, from being specialists in manufacturing their products and in their sales and supply chain, to increasingly offering their products with a higher degree of personalisation and with more value. Likewise, car manufacturers now wish to complement their core business by integrating and aggregating mobility services. Furthermore, Figure 3 also considers

[13] For more info, see: https://smartcity.wien.gv.at/site/en/smile-2

indirect services such as parking, classifying its infrastructure as an aggregated service, and the software for booking and paying it, as a service that could be integrated in vehicles.



Note: SU=Suburban, LD=Long-Distance, HW=Hardware, SW=Software

Figure 3. Building a *Total Mobility Provider* combining Amazon and Apple business models (Van Audenhove et al., 2014).

In view of recent trends indicating a willingness of companies towards building strategic partnerships with complementary businesses or even competitors, enabling them to improve their offer and competitiveness, the concept of the business ecosystem is becoming prominent (Graça & Camarinha-Matos, 2017). The term "business ecosystem" was introduced by Moore in 1993, when he suggested that a company should be viewed as part of an ecosystem crossing a variety of industries instead as a single industry (Moore, 1993). Moore (1993) stated that *"in a business ecosystem, companies coevolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations"*. Also, Heikkilä & Kuivaniemi (2012, p. 19) added that *"similar to a biological ecosystem, a business ecosystem is formed by large, loosely coupled networks of entities. These entities such as firms, organizations, entrepreneurs, etc. interact with each other and the health and performance of each actor is dependent on the health and performance of the whole"*. In addition, Moore (1993) specified that *"every business ecosystem develops in four distinct stages: birth, expansion, leadership, and self-renewal or, if not self-renewal, death"*. The author described the business ecosystem as a 3-layer-relationship structure (Figure 4), each of them corresponding to a different level of commitment to the business: the core business area, where the parties being the heart of the business are found; the extended enterprise layer, which comprises the operations supporting the core business, such as direct and indirect customers and indirect suppliers; and the business ecosystem layer, which includes the owners and stakeholders as well as other powerful actors related to the business, such as labour unions and regulatory bodies (Yoo et al., 2014; Heikkilä & Kuivaniemi, 2012).

When Moore's business ecosystem is applied to the mobility sector, and from the perspective of being a MaaS provider, the core business parties would be the transport operators, data providers and customers; the extended enterprise layer would comprise second-layer suppliers such as providers of insurance, Information and Communication Technologies (ICT) infrastructure, and ticketing and payment solutions; and the outermost layer would involve the parties not directly involved in the business operations but essential for the success of MaaS (Kamargianni & Matyas, 2017). Figure 5 illustrates the MaaS ecosystem following Moore's theory, but with one discrepancy, the placement of customers in the core business area instead of in the extended enterprise layer, which makes perfect sense since services are increasingly becoming user-centred. Furthermore, when automotive OEMs turn into MaaS providers, the services classified as integrated in Figure 3 would become the core business, and the aggregated services would built the extended enterprise layer.

Moore pointed out in 2006 that the application of this *"system of complementary capabilities and companies"* is nothing new, since the auto industry has always been *"a capital-intensive business with multilayer product cycles, massive retooling for each generation of cars, and a semiskilled labour force of thousands"* with *"automobile-centric business ecosystems"*, including a large variety of complementary goods required for cars to be useful, such as roads, service stations, component manufacturers and dealerships (Moore, 2006, p. 38).

To summarise, we are facing various business ecosystems in the mobility sector powered by a wide range of actors, either alone or in co-operation with other companies, from start-ups searching a market niche to automakers, insurance companies, or public transportation providers. Accordingly, car manufacturers have started to build alliances and partnerships with both automotive (e.g. the competitors Mercedes, BMW, and Audi acquired the location platform Here[14]) and nonautomotive players (e.g. shared mobility providers) to shape ecosystems with additional capabilities and functionalities that automotive OEMs alone could not offer (McKinsey&Company, 2015). In this regard, McKinsey&Company (2015, p. 26) stated that *"57% of automotive executives anticipate opening up their software/Application Programming Interface to third parties or external software developers"*. The report also affirmed that the business ecosystem with the higher number of players would be the one offering a higher value of service and, therefore, the one with more possibilities of success.

[14] For more info, see: https://www.here.com

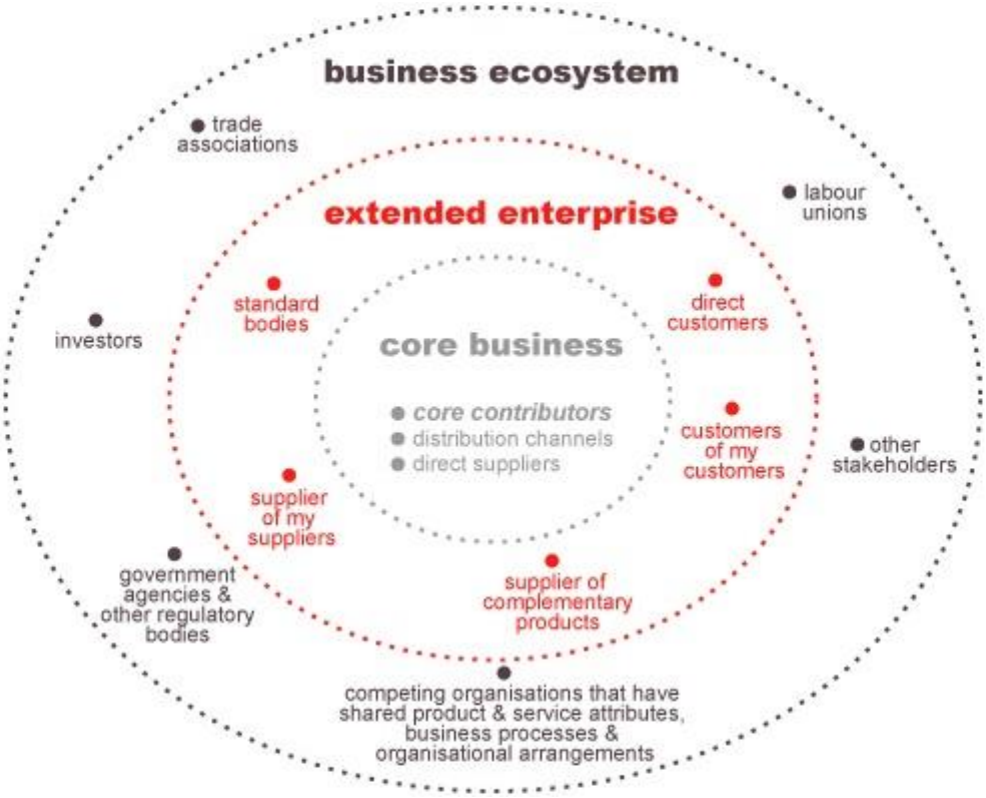


Figure 4. Moore's business ecosystem (Dykshoorn et al., 2011).

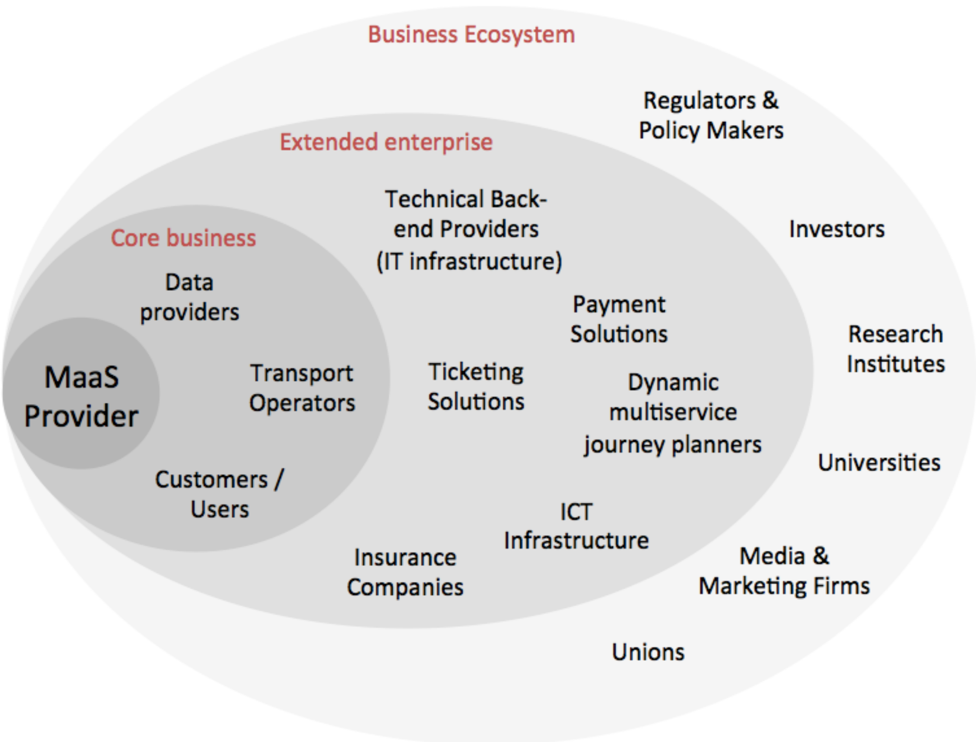


Figure 5. The MaaS ecosystem (Kamargianni & Matyas, 2017).

2.2.3 The future of the Automotive Industry

According to KPMG International (2017, p. 11), *"the auto industry is lost in translation between evolutionary, revolutionary, and disruptive key trends that all need to be managed at the same time"*, meaning with key trends the electrification of vehicles, considered the top one, followed by connectivity and digitalisation, platform strategies, value of big data, MaaS, and self-driving cars, among others. In addition, Attias (2017, p. 100) considered autonomous cars as *"the origin of the greatest revolution that the automobile has ever known"*, and also as the city cars of the future.

The revenues and profits of the automotive industry are expected to change, as software and digital and mobility services are becoming increasingly important. By 2030, it is estimated that vehicle sales would be lower (and with the forecast of a 5% drop in revenue versus 2015, it is estimated that profits would fall by 12%), and therefore, the revenues and profits from after-sales services, financing, and insurance would also decrease; as would the activity of hardware suppliers (software and digital services providers would increase their activity, as they come from a residual role in 2015); in contrast, shared mobility services would have around 10% of revenues and 20% of profits, only 9 points below the profit derived from vehicle sales (Baker et al., 2016).

On the other hand, Bert et al. (2016) highlighted that only carsharing would reduce 550,000 vehicle sales by 2021, causing to automotive OEMs a net revenue loss of 7.4 billion €. According to the former CEO of moovel Group, Robert Henrich, new intelligent solutions would be required to cover people's mobility needs, since it is expected that by 2050 the total passenger travel distance would exceed 70 trillion kilometres per year, the double of today, and inner-city kilometres travelled (64% of the total) would double or even triple (Mortkowitz, 2015; EY Global Automotive Center, 2013). Although car sales decrease, Henrich stated that automakers do not necessarily have to lose customers, since the services provided will help to retain them, and also added that the automotive industry is in a good position to lead the mobility ecosystem of the future (Mortkowitz, 2015).

Additionally, new mobility services such as P2P carsharing, with which owners could produce additional income renting their cars during their non-use periods, could make ownership more attractive, since it would facilitate that consumers unable to purchase a car could own one, and it would give reason to low-usage users to also own a car (Abhishek et al., 2016). The authors noted that automotive OEMs could promote this type of carsharing to increase their car sales and mentioned that some of them are already considering having their P2P rental platforms, such as Tesla, which included this option in its Master Plan. Tesla planned to create its own shared fleet with cars from owners willing to generate income when not using their vehicles, and to operate them in cities with higher demand than supply to enable the carsharing service everywhere (Musk, 2016).

In parallel, other strategies are being explored, such as connectivity, of which Martin Winterkorn (former CEO of Volkswagen Group) stated that *"the cost is minimal relative to the cost of not getting connected to our cars"*; customer experience, of which Moritz von Grotthuss (former CEO of gestigon) considered the car to be part of the consumer's digital lifestyle like the iPhone, if made equally simple to use and attractive; and partnerships, of whom Martin Kristensson (Director Connectivity Strategy at Volvo Cars) noted that *"most consumers spend only one hour a day in their cars and only one hour away from their phones. If Google and Apple can provide good solutions for the car, it's good for our customers and therefore good for Volvo"* (Mortkowitz, 2015, p. 5,8).

Although, Hietanen (2016) expressed that traditional players such as auto manufacturers should enable the new mobility scenario providing open and pluggable vehicles, but not becoming service providers as they would need a lot of new competencies, Frost & Sullivan (2016a) also foresaw vehicle manufacturers developing their own mobility solution division in addition to manufacturing, and tying up with payment enablers and data integrators among other partnerships. This report noted as well that automotive OEM-owned and OEM-operated mobility services would be able to better control their fleet of vehicles and to eliminate middlemen in the value chain, increasing profitability and the potential of reducing prices; on the contrary, they could only offer services of OEMs' portfolio, being maybe too limited for customers and threatened by standardisation of in-vehicle systems, causing difficulties to differentiate brands. Frost & Sullivan (2016a) made three big predictions: vehicle manufacturers with a strong multifaceted strategy are expected to win against pure-play-proprietary-solutions-oriented manufacturers, which will suffer to remain profitable; manufacturers, as well as Google, are expected to leverage consumer metadata coming from connected cars and apps, which will give them a competitive advantage over other potential disruptors; and lastly, automotive OEMs will need strategic partnerships, mergers, and acquisitions to attract more customers.

2.2.4 User experience as a differentiator factor

Andreas Mai (former director of Smart Connected Vehicles at Cisco) and Dirk Schlesinger (CDO at TÜV SÜD and former executive at Cisco) stated that *"it is no longer enough to sell personal transportation"* and added that *"people want a personalized driving experience that keeps them connected to everything that is important to them: friends, information, music, maps, schedules, and more. Connected cars could do for the automotive industry what smartphones did for the phone industry"* (Fishman, 2012, p. 24).

Fishman (2012) foresaw that mobility would be massively networked (city connected to vehicles and other transport services, which at the same time are connected with their users), dynamically priced (based on different variables such as the time of the day and the demand), integrated (to enable easy and seamless mobility), reliant on new models of public-private collaboration (shaping the new transportation ecosystem), and user-centred (providing a range of services and real-time information on them to cover all their needs and priorities). Regarding the user-centred approach, the report added that the reason for the automobile's popularity was user's control of the service, comfort, and convenience. Therefore, a wider offer of integrated services with available real-time information for users, convenient for different trip purposes and accessible to all inhabitants (disabled people, seniors, kids, etc.) could meet and even overcome vehicle's popularity. Van Audenhove et al. (2014) also stated that transport operators would need to evolve from administering logistics to serving customers, with a decision-making process where user interests are the priority. The report justified this need declaring that a superior customer experience is needed, more concretely, an emotional experience that enabled turning customers into fans, since *"the emotional experience is what makes the difference"* (Van Audenhove et al., 2014, p. 35). Accordingly, Hietanen (2016) expressed that understanding the value of aspiration and bring it into the service design could be the key to success. In this context, Grotthuss suggested that in-car experience must be made as simple and fun as the first iPhone, which brought emotion and also easiness, and therefore suited everybody (Mortkowitz, 2015).

When talking about seamless integrated mobility services or MaaS, Henrich underlined the importance from the first step with the application until the last, with the end of the trip: *"because the customer expectation when it comes to the app is high, you need to give him the full package. When he wants to rent a car, for example, he just presses a button and the car unlocks and he can drive. If he wants to go with public transit, it needs to be in the same app, fully integrated, and he pushes a button, the mobile ticket comes up and off he goes"* (Mortkowitz, 2015, p. 15). Additionally, Kamargianni & Matyas (2017) suggested that subscription packages could include extra services, such as Wi-Fi, free access to newspapers, magazines, and different options of entertainment (music, movies and gaming) and even offer discounts for shops and restaurants.

Furthermore, Stefan Butz (Vice President at BMW) believed in creating customer loyalty through digital experience and declared that *"at BMW, we are thinking a lot about transforming the car into a digital mobile world",* as well as that future customers will have Digital Identities (IDs), which will enable them to improve their mobility experiences (Mortkowitz, 2015, p. 9). Accordingly, Johann Jungwirth (former CDO of Volkswagen Group) declared that the creation of customer IDs and profiles usable within the 12 brands of the group, and which would enable the creation of a digital space around the customer, was a priority for the group (Frost & Sullivan, 2017). In that interview, Jungwirth stated that *"this profile will grow/become rich over time using artificial intelligence and customers can carry this across vehicles within Volkswagen be it seat settings, climate control, ambient lighting"* and therefore, that *"it will be positive locking and it will be difficult for people to leave their digital profile and move on to a rival brand"*. Consequently, technology and data are meant to be key elements for improving customer experience, as well as designing the services with a user-centred focus, but neither of these features will bring differentiation between competition. However, design and loyalty through IDs or programs could provide a unique customer experience, and perhaps the key to success in the new mobility era.

Summing up, there is an increasing offer of mobility services in urban areas, but also of mobility providers. Emerging start-ups identified a market-niche and proposed different mobility services based mainly on the sharing economy. And due to its strong market reception and its perspectives once the vehicles are connected and autonomous, technological firms, automotive OEMs, rental car companies, and insurers are also exploring this area. Since these players come from different backgrounds, they are partnering with other players to start offering different mobility services or even shaping business ecosystems. The near future looks really bright for citizens, since they might have a lot of mobility options to choose. The numerous mobility providers could face a strong competition, and if all of them offer similar services, few might stand out. They might need, for example, to specialise in some segments, in some services, or in some cities or countries to better cover the needs of their customers. Or perhaps the differentiator factor could be user experience, through service design, connectivity, personalisation, or loyalty services.

2.3 CLASSIFICATION OF SHARED MOBILITY BUSINESS MODELS

A number of papers have suggested a classification of app-based car-related shared mobility services. Regarding carsharing services, Shaheen et al. (2012) identified four models of Peer-to-Peer (P2P) carsharing according to the business model portion of the carsharing platform; Cohen & Kietzmann (2014) and Münzel et al. (2017) distinguished between the business type (B2C, P2P, non-profit, and cooperative carsharing) and the operational model (point-to-point and round-trip); Remane et al. (2016) divided carsharing business models into 7 clusters according to the business type: the operational model, the vehicle offer, and the type of access (manual or automatic); and Rotaris & Danielis (2017) classified the service according to who owns and maintains the car. Furthermore, Bälan (2016) classified the main models of carsharing, ridesharing, and ride-hailing that exist in Romania, regardless of whether or not they are profitable; and Chan & Shaheen (2012) distinguished between different types of ride-sharing based on the relationships among their participants.

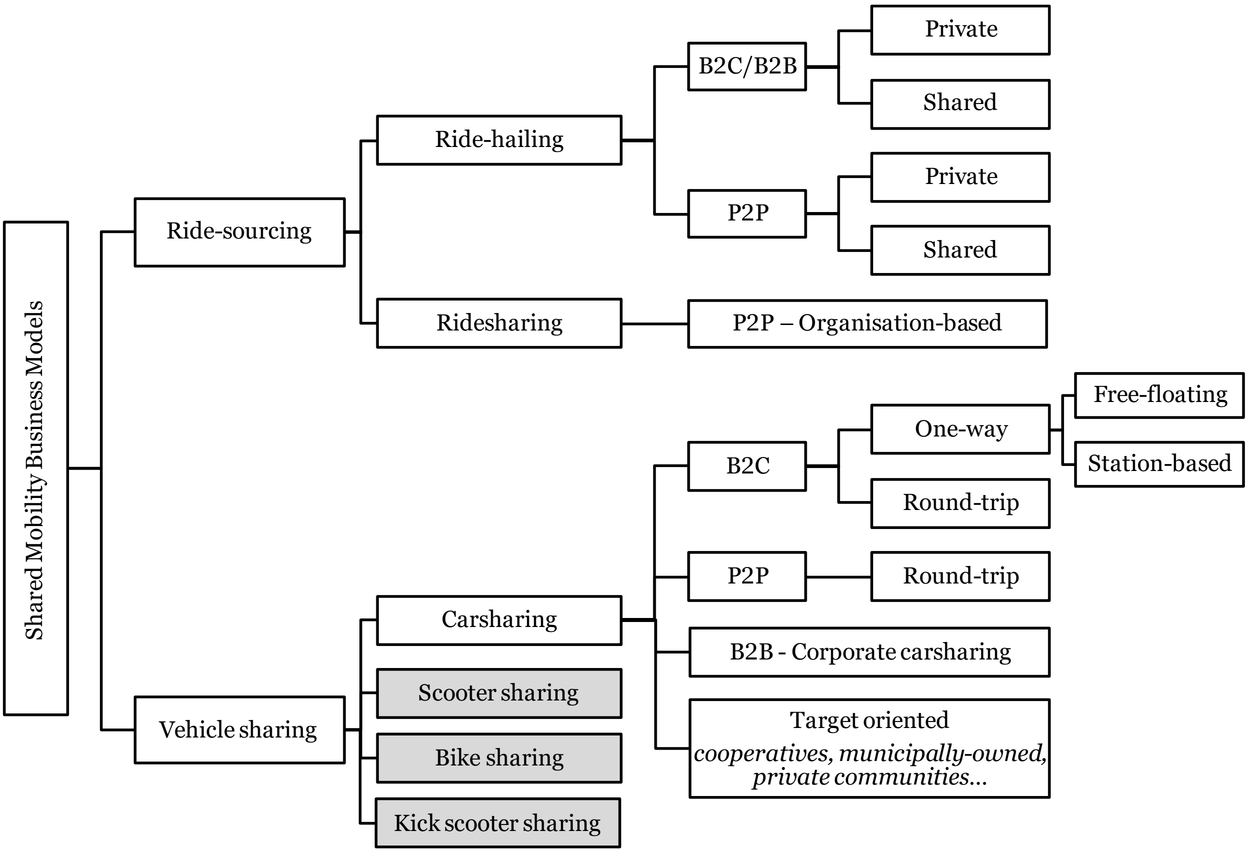


Figure 6. Classification of for-profit car-related shared mobility business models from the business point of view.

It can be observed that these papers used different business characteristics to classify the mobility services being considered. Hence, to give a general overview of all types of for-profit services, we present a more comprehensive classification that summarises the several classifications provided by the above-mentioned studies (Figure 6). First, we divide the shared mobility business models into two main areas: ride-sourcing, which refers to the services of ride-hailing and ridesharing; and vehicle sharing, which is based on renting vehicles for short periods of time.

Ride-hailing is interpreted here as the business model that operates like taxis, with the difference being that this service is not authorised to pick up street hails and, therefore, requires passengers to previously book their trips. As defined in Figure 6, ride-hailing is divided into private B2C/B2B (chauffeur driven vehicles commonly called VTC services, i.e., Chauffeured Tourism Vehicle), private P2P, where people seek economic remuneration by working as drivers and using their cars to carry passengers to their destinations, and shared B2C and P2P models (i.e. shared ride-hailing). On the other hand, ridesharing is defined as a non-profit activity, where both drivers and passengers share similar destinations and decide to share trips in order to share travel costs (Chan & Shaheen, 2012). However, some for-profit services exist, such as BlaBlaCar [15] and Amovens [16], who apply an organisation-based model using internet platforms. Therefore, in this paper only the ridesharing organisation-based model that operates through for-profit internet platforms is analysed. To summarise, the main difference between shared ride-hailing and ridesharing is: in the former, drivers are employed or work freelance, whereas in the last, drivers seek only to share the costs of their regular or occasional long trips. It is worth noting that this difference will disappear once these services are offered with autonomous vehicles.

Finally, carsharing business models are classified into four business types: B2C, P2P, corporate carsharing, and target-oriented (e.g., cooperatives, municipally owned, and private communities). In the case of corporate carsharing and P2P, they usually operate using the round-trip mode, where users are requested to return the vehicles to the pick-up locations. However, some P2P carsharing services also offer the option of requesting and offering a home pick-up and delivery service. B2C carsharing services can be found that use either round-trip or one-way modes. The one-way (or point-to-point) type enables users to return the vehicles near their destinations at specific points (station-based) or directly on the streets (free-floating or flexible). Therefore, the one-way model is suitable for short urban trips; whereas the round-trip type covers longer distance trips.

[15] For more info, see: https://www.blablacar.com
[16] For more info, see: https://amovens.com

Chapter 3. ANALYSIS OF APP-BASED CAR-RELATED SHARED MOBILITY BUSINESS MODELS FROM AN INTEGRATED PERSPECTIVE

Nowadays, users of carsharing, ridesharing, and singular and shared ride-hailing services often need to be customers of more than one service to cover all their transport needs, since most services providers offer their different mobility services separately (i.e. not sharing the application, vehicles and staff with other services offered by the same company). In addition, many of these transport services are unprofitable, and for this reason end up closing down, moving to other cities, or changing their business models.

Hence, the aim of this chapter is to find out synergies between the different app-based car-related shared mobility services that foster the development of new business models, to increase the profitability of these services.

This research is addressed by examining relevant similarities and differences among carsharing, ridesharing, and singular and shared ride-hailing services using the Business Model Canvas (BMC) methodology (Osterwalder et al., 2005) and relying on different sources of information: literature review, services websites, face-to-face interviews with users and drivers, and personal experience.

First, the methodology used to conduct the research process is explained. Then, the main characteristics of app-based for-profit car-related shared mobility services business models are presented, based mainly on the literature review and services websites, through the nine building blocks of the BMC. Finally, the discussion and conclusions of the conducted research are given.

3.1 METHODOLOGY

We investigated the common features and differences of the different types of app-based car-related shared mobility services by analysing their business models by means of the BMC methodology. The BMC provides a detailed and clear visual overview of how business operates, and it is a helpful tool for identifying what activities are the most important for creating and delivering value to stakeholders while generating innovative revenue streams.

First, we conducted a literature review based on specific research using as keywords the combination of the terms “business model” with “shared mobility”, “mobility services” or the names of the existing car-related shared mobility services: “carsharing”, “ridesharing”, and “ride-hailing”. We conducted the search in the electronic databases SCOPUS and Web of Science from the 1st January 2000 until the 31st December 2018.

Second, to include the commercial and operational perspective in our research, we inspected the websites of 19 outstanding services of singular and shared ride-hailing, B2C and P2P carsharing, and ridesharing, few of them being offered by the same provider and through the same application.

Finally, to appreciate the differences between these transport services and better define their value proposition and the targeted customer segments from users' point of view, as well as the strengths and weaknesses of the services, we reviewed the last users' comments posted on their App Store and Google Play pages (Apple Inc., 2018; Google, 2018), we experienced some of the services, and conducted 30 semi-structured face-to-face interviews with users and 7 with drivers of ride-hailing and ridesharing services. Both the surveys and the tests were conducted in different cities of Spain, Germany, and the United States.

With regard to the interviews, we mainly asked users the following questions: when and why they used the specific services, what they liked and disliked, and why they did not choose other transport services for these trips. As for the drivers, we asked them why they drove for the service, and also, what they liked and disliked.

Table 2 specifies the services that have been reviewed through their websites and App Store and Google Play pages by type of service, and the number of conducted interviews and tests for each type. Data was collected from July 2017 until December 2018 and was classified, just as the literature review, according to the 9 building blocks of the BMC.

Table 2. List of services reviewed through their websites and number of interviews and tests conducted, by type of service.

Type of service	Operating services reviewed	No of interviews and tests
Ride-hailing	Singular Didi[17], mytaxi, Gett[18], Uber, Lyft, Cabify[19], ReachNow[20]	10 users 3 driver 5 tests
	Shared Via, CleverShuttle[21], UberPOOL[22], Lyft Line[23]	7 users 2 driver 3 tests
Ridesharing	Blablacar, Amovens, WazeCarpool[24]	3 users 2 drivers 2 tests
Carsharing	B2C Zipcar, car2go, DriveNow[25], ReachNow, Respiro[26], Wible[27]	8 users 2 tests
	P2P Drivy[28], SocialCar[29], Amovens	2 users

[17] For more info, see: http://www.didichuxing.com/en
[18] For more info, see: https://gett.com/uk
[19] For more info, see: https://cabify.com
[20] ReachNow ended service on July 2019. For more info, see: https://www.reachnow.com
[21] For more info, see: https://www.clevershuttle.de
[22] For more info, see: https://www.uber.com/es/en/ride/uberpool
[23] For more info, see: https://www.lyft.com/rider
[24] For more info, see: https://www.waze.com/carpool
[25] For more info, see: https://www.drive-now.com
[26] For more info, see: https://respiro.es
[27] For more info, see: https://www.wible.es/en
[28] For more info, see: https://www.drivy.com
[29] For more info, see: https://www.socialcar.com

3.2 Business Model Canvas perspective on Shared Mobility Services

In this subsection, all the information obtained from the literature review, the websites of existing mobility services, their App Store and Google Play pages, the tests, and the interviews is analysed using the nine building blocks of the BMC: Customer Segments, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, and Cost Structure, which are explained in Figure 7.

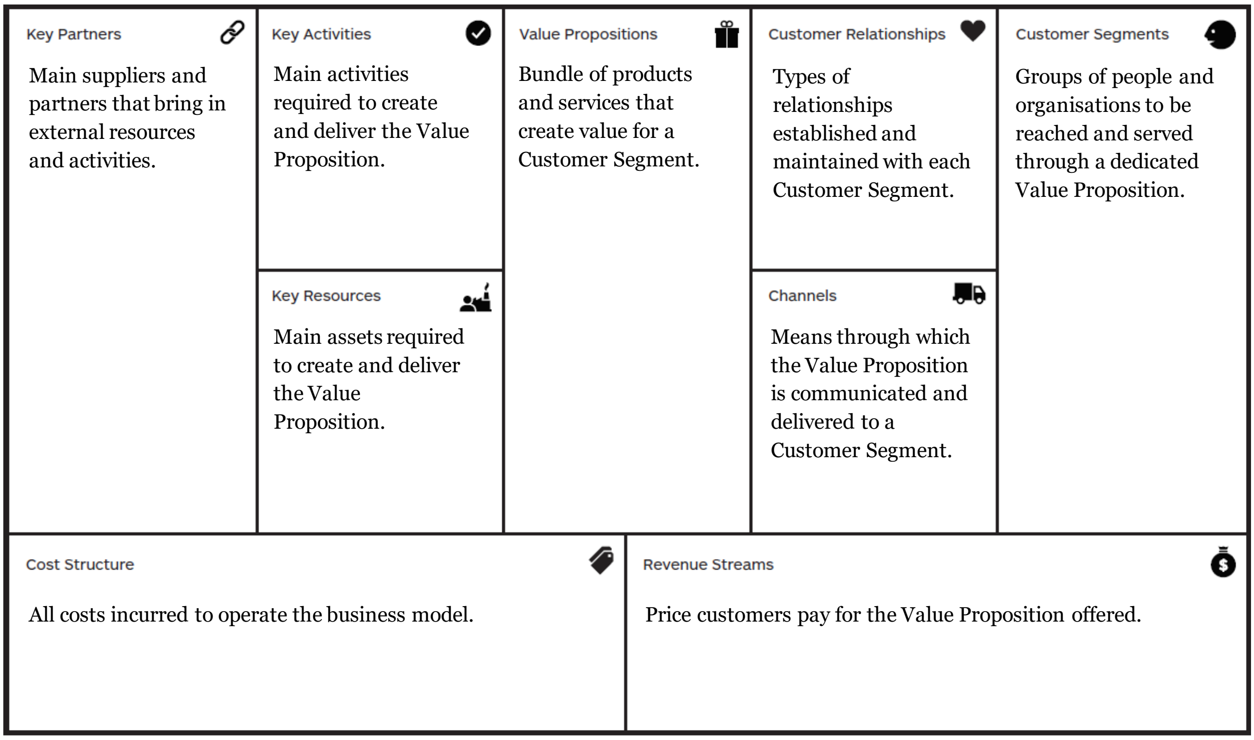


Figure 7. The Business Model Canvas with the description of the 9 building blocks (adapted from Hanshaw & Osterwalder (2015)).

Next sections are devoted to analyse each of these blocks. Then, a summary of the key features of each building block, per type of service analysed –ride-hailing, ridesharing and carsharing– is provided (Figure 8).

3.2.1 Customer Segments

Car-related shared mobility services are oriented toward private customers, business clients and public authorities (Hunke et al., 2017). The majority of them require that users be holders of a smartphone and a credit card, debit card, or a digital payment account, which together guarantee the reservations and cashless payments.

Some ridesharing and shared ride-hailing services target specific Customer Segments, such as commuters (Waze, 2018; Via, 2018) or long distance travellers (Mazzell & Sundararajan, 2016). On the other hand, singular ride-hailing services mainly target leisure, city night uses, and other short trips barely covered by public transport or covered but with low comfort, such as trips to the airport (Lyft, 2018).

On the other hand, Cohen & Kietzmann (2014) stated that carsharing addresses individuals who aim to shift from ownership to a shared vehicle (B2C model) or to sharing the vehicles they own when not in use (P2P model). Shaheen & Cohen (2013) highlighted the potential of the neighbourhood, business, and university customer segments for being predominant market segments as well as the most profitable markets. Likewise, the authors studied the carsharing addressed to government and institutions, public transit, and vacation resorts and tourist locations. In addition, Lesteven & Leurent (2016) proposed a type of carsharing for tourists and Rotaris & Danielis (2017) analysed the university-sponsored carsharing targeting students and employees, the carsharing provided by public transport operators targeting public transport users, and the carsharing services owned by municipalities.

3.2.2 Value Propositions

Although each mobility service has its particular value proposition, they all have two main features in common: they are app-based and they can contribute to improve mobility, mainly in urban areas, by reducing car ownership. The greatest difference between these new transportation services and the traditional ones is that they use the latest technology, which enables users to book, ride, drive, and pay in a flexible, easy, and convenient way. Furthermore, Watanabe et al. (2017) pointed out that Uber (ride-hailing service) enables a faster and less expensive search for transport and a better utilisation of assets, benefits that are also offered by the other car-related shared mobility services.

Ride-hailing services are growing as an alternative to taxis, as they offer flexible and low cost on-demand rides easily while providing a better user experience (Bonazzi & Pigneur, 2015; Janasz & Schneidewind, 2017; Gao & Zhang, 2016; Watanabe et al., 2016). However, Uber and Cabify could be more expensive when the user requests a luxury car or when there is more demand than supply. Cabify also gives the option to request child seats and it offers premium facilities such as WiFi, a bottle of water, and the possibility of choosing the music and temperature during the trip. According to our interviewees, their speed and convenience is what convinced them to use these services instead of using public transport, and because of their low and guaranteed fare they chose them instead of the taxi. According to Janasz & Schneidewind (2017), ride-hailing services help solve the first- and last-mile problems. Watanabe et al. (2016) added that they also provide real-time information on the Estimated Time of Arrival (ETA) and cab position, cashless payment and time savings in reaching a location. In addition, some ride-hailing services provide the user with information on the assigned driver (picture, name, rates, etc.) and they offer centralised invoicing to businesses. Watanabe et al. (2016, 2017) noted as well that ride-hailing gives transparent overview of the quality and prices. Ride-hailing is also found in the shared version, such as the operating services UberPOOL and Via.

Concerning ridesharing services, they facilitate to arrange shared trips in advance, in order that passengers can share the costs of their occasional or recurring trips between the driver and the riders, without the driver charging more money than is needed to cover the costs of fuel and vehicle depreciation. To make ridesharing easier and more flexible, this service is evolving towards real-time ridesharing (Raney, 2010; Chan & Shaheen, 2012; Janasz & Schneidewind, 2017). These authors highlighted the directly related benefits from the use of ridesharing, which are reductions in traffic and greenhouse gas emissions.

On the other hand, carsharing offers easy access (no paperwork required and vehicles are usually nearby) to car rentals by the minute or by the hour, usually with digital access (via a subscription card or the app). It is available at any time of the day, on-demand or with a previous booking, and without the need to return the vehicle to the pick-up location (one-way type) (Cohen & Kietzmann, 2014; Hoffmann et al., 2014; Wu, 2016; Remane et al., 2016; Janasz & Schneidewind, 2017). Interviewees without access to a car found carsharing very useful for day/weekend trips, to reach remote areas such as industrial parks or university campuses, and to return home after shopping. Hoffmann et al. (2014) proposed a service with a variety of car models to cover all user needs, recommended an electric fleet to move within the city centres, suggested that locations and charging stations be easily reachable and near public transport, and they mentioned users' desire for reserved parking spaces and the ability to return cars anywhere in the country. On the other hand, Cohen & Kietzmann (2014) mentioned that P2P carsharing enables car owners with underused vehicles to rent them per day in exchange for an additional source of income.

3.2.3 Channels

App-based mobility services mainly reach their customers through their own services' applications or through multimodal applications provided by MaaS platforms that include them. The majority of the user complaints of the services analysed posted on App Store and Google Play were related to app problems or bad customer service experiences. Therefore, if the application, which is the main channel, is not user-friendly or fails, not only the delivery of the Value Proposition fails, but also there is a high risk that users stop using the service. Another common and key channel for all these services is their website, since customers usually look up information here about the services and even sign up as users. In addition to well designed and user-friendly mobile apps and landing pages, communication and advertisement of these services also use email and social media marketing, online campaigns, content marketing, and multichannel B2B marketing for the corporate segment (Janasz & Schneidewind, 2017). Furthermore, Hoffmann et al. (2014) highlighted the importance of having a hotline to book the service in the case of ride-hailing services.

Other channels for ridesharing services are meeting places such as park and ride facilities and transfer hubs (Raney, 2010; Chan & Shaheen, 2012; Cohen & Kietzmann, 2014). What is more, some companies encourage their employees to commute by sharing trips with other employees (Janasz & Schneidewind, 2017).

Further essential channels that enable users to access carsharing services are also parking areas, and for e-carsharing, charging stations (Shaheen et al., 2012; Hoffmann et al., 2014; Herrador et al., 2015; Reiner & Haas, 2015; Remane et al., 2016; Janasz & Schneidewind, 2017).

3.2.4 Customer Relationship

Both the applications and websites of the mobility services reviewed provide a self-service interface for customers to help themselves, although all of them offer a customer support service. However, users also need personal assistance when signing up for a carsharing service or as drivers for a ride-hailing service, since documentation needs to be checked, and problems need to be resolved, such as when the requested ride-hailing or ridesharing service does not arrive, the door of rented car does not open, or the cost of the service is not correct. An important number of the reviews posted on App Store and Google Play are complaints to customer service, for being slow, not helpful, or difficult to reach. Apart from that, a reputation system based on ratings or social media is widely used among these services, since it is important to enhance user confidence and ensure the trust and safety of users (Shaheen et al., 2012; Wu, 2016). To retain customers, some services also offer loyalty programs. Bonazzi & Pigneur (2015) suggested social gatherings for riders and drivers and the gamification of the application. Regarding ride-hailing services that employ their drivers, these drivers also provide human interaction with the users.

3.2.5 Revenue Streams

Emerging mobility services generally charge their customers per use; however, many B2C carsharing services, such as Zipcar and Respiro, use a combination of a subscription fee and a usage fee, adapting the fee per use to the subscription chosen. Perboli et al. (2018) emphasised the importance and also the complexity of creating customised tariff plans for carsharing services.

The majority of ride-hailing services apply a rate per kilometre and/or per minute –pay-per-use method–, but there are also a few of them that offer flat rates (Janasz & Schneidewind, 2017; Pakusch et al., 2016). Moreover, during periods of high demand, Uber uses dynamic pricing to match the supply with the demand and Cabify applies an extra charge. Other extra charges are applied when requesting a service with a premium vehicle or with child seats, among other options. In P2P services, the platform charges a commission per trip, which in the case of Uber is 20% (Cohen & Kietzmann, 2014; Gao & Zhang, 2016; Wu, 2016).

Ridesharing services such as BlaBlaCar and Waze Carpool charge a service fee to cover the operating expenses of the platform. For instance, BlaBlaCar's commission is around 17% of the cost of the trip (BlaBlaCar, 2016). Other operators such as TwoGo by SAP are subscription-based or they apply a freemium model (Janasz & Schneidewind, 2017).

Regarding carsharing services, Remane et al. (2016) specified that their revenue model is based on a price structure that is either determined by the duration of the rental or a combination of the duration and the distance travelled. It also relies on continuous revenues and transaction-based revenues. The continuous revenues identified by Cohen & Kietzmann (2014) and Remane et al. (2016) were membership and service fees from users, government subsidies and grants, and sponsorship and advertising. Münzel et al. (2017) distinguished the fee structure used by the operators, depending on the type of carsharing provided. Through their analysis, the authors found: most of the carsharing operators in Germany charged a registration fee, except in the case of the P2P model; cooperatives and B2C round-trip services usually also charged a monthly fee; and regarding the rate per use, operators of B2C round-trip services and cooperatives charged per hour or per day whilst operators of B2C one-way charged a by-the-minute fee. Interesting is the pricing model of Wible, which charges a by-the-minute fee within the first hour, per hour from the second hour onwards or a daily rate, thus combining the one-way and round-trip uses as well as the traditional car rental. And Zipcar and Respiro adapt their rates depending on their different monthly subscription plans. The cheapest plan offers the most expensive rates per rental and the most expensive plan offers the cheapest rates. Additional fees could be applied depending on the car model chosen, the destination of the trip (e.g. starting or ending a rental at an airport), or for extending a reservation, which is how DriveNow works. On the other hand, P2P carsharing platforms ask for neither registration fees nor monthly fees (Wu, 2016; Münzel et al., 2017), but instead usually charge per day, as in the case of Amovens and Drivy. In this category, the prices are not regulated, leaving car owners the freedom to set the prices for their vehicles. The carsharing platform functions as an agent that collects payment for each rental and keeps a commission for each transaction, which could be up to 25%, as in the case of Turo (Wu, 2016).

3.2.6 Key Resources

Vehicles and software (user application and technological platform) are the main and common key resources of any car-related mobility service, followed by the charging infrastructure if the vehicle fleet is electric. Also, resources such as smartphones and digital payment (Watanabe et al., 2016), as well as data, capital, and specialists (Hunke et al., 2017) are required for operating these services. Other key resources vary according to the different service categories.

For Ride-hailing services, in addition to the technological platform required for the characteristics of this type of service and the application for ordering rides, the following assets are equally important for being able to offer the corresponding value proposition: skilled drivers (on some occasions they are also required to hold a taxi or a VTC license, depending on the service provider and the place where the service is offered); the driver application (needed to receive user requests); vehicles adapted to the features of each service (basic, premium, sustainable, etc.); algorithms that provide routing, match different users going in the same direction and who are willing to share the ride (in the case of shared ride-hailing); algorithms that determine surge pricing, depending on the demand and supply of the moment (in the case of Uber); insurance for the service provided; and investors, who are willing to acquire a fleet of vehicles and VTC licenses, or invest money in the corresponding service provider.

Concerning ridesharing services, Raney (2010) demonstrated the importance of GPS smartphone technology and text messaging to enable real-time ridesharing and social networks to improve the user's experience. And Janasz & Schneidewind (2017) added the use of automated ride matching software applications.

Carsharing services require some additional key resources: digital access technology that enables users to open the rented car by means of their smartphones, on-street and off-street parking spaces, insurance, and investment (Hampshire & Gaites, 2011; Shaheen et al., 2012; Janasz & Schneidewind, 2017). Furthermore, Shaheen et al. (2012) added the importance of integrating in-vehicle technology, such as control and security mechanisms, and in-vehicle data recording and transmission devices.

3.2.7 Key Activities

All the services analysed require a technological platform as a key resource. All of them must optimise and manage their online platforms as well as promote them to continue acquiring customers and establishing new partnerships. Also, strong customer support in case of doubts or emergency is key to ensure the proper use of the service and to maintain and increase the user base. Additionally, Ferrero et al. (2018) highlighted the importance of an optimised fleet management and infrastructure for carsharing services, understanding fleet management activities to not only ensure that cars are in the proper condition (clean and charged/tank filled), but also the planning of the fleet size, relocation strategies, pricing, and parking policies. These activities must also be conducted in ride-hailing services. However, the different service categories have distinctive features, meaning that key activities can differ depending on the corresponding service.

The key activity of ride-hailing services is to operate a fleet of vehicles in order to offer on-demand rides, and in the case of shared ride-hailing, on-demand shared rides. To make this happen, the most important actions required are varied: development and optimisation of the online platform that enables the service and, among other functions, connects drivers with passengers; development and optimisation of both user and driver applications; development and optimisation of the algorithms for routing, matching, and surge pricing (if applied); obtaining and providing real-time information on the ETA and vehicle position in relation to the customer; management of the fleet; management of the reservations, cancellations, payments, and contracts; marketing to acquire drivers and passengers; and community management, in order to retain them. From the experience of Uber in China, Gao & Zhang (2016) highlighted key activities such as recruiting skilled drivers and providing excellent customer services to riders and drivers while building good relationships with partners. In addition, they highlighted the importance of making it easy and convenient for drivers and riders to locate each other, and also eliminating potential risks by insuring passengers. Watanabe et al. (2016) also noted that big data analysis is an essential element and Willing et al. (2017) explained the value of customer data analytics in optimizing a service area or in tailoring any service offer. On the other hand, P2P ride-hailing services offer flexible jobs for drivers who may or may not have their own car, depending on the service provider. Some of them also offer financial aid for buying a vehicle and discounts on fuel and insurance. In this way, a key activity for P2P ride-hailing is to provide its drivers *"with a highly efficient operation without additional investment and license fees"* (Watanabe et al., 2016, p. 166).

The function of a ridesharing service is to connect drivers and riders going to the same destination. Since on many occasions the users do not know each other, building trust was highlighted as important by Mazzell & Sundararajan (2016). Ridesharing services are also responsible for managing the bookings and cancellations, charging the users, paying the drivers, and managing the rideshare community to attract users and spread trust.

Carsharing services provide short-term vehicle rentals, either on-demand or by reservation. As mentioned earlier, the key activities of carsharing include, among others, the development and optimisation of the booking system's technological platform, real-time information on the availability of vehicles, and the development and optimisation of the website and user application. However, that is not all. Carsharing providers must also: manage their vehicle fleets and keep them clean, fuelled or charged, and repair and relocate them when necessary; manage the reservations, cancellations, payments, and contracts; and conduct marketing campaigns. In the case of P2P carsharing, they must provide the tools (on the online platform) that enable car owners to quickly and easily publish and update the information and availability of their vehicles. Moreover, they need to attract users and car owners (P2P model) to manage the community of users and analyse the data on the operations to improve the service.

3.2.8 Key Partnerships

Local governments should be involved as stakeholders in defining the operation of shared mobility services in the cities (Firnkorn & Müller, 2012; Cohen & Kietzmann, 2014; Herrador et al., 2015; Sochor et al., 2015; Watanabe et al., 2017; Janasz & Schneidewind, 2017), since these strategic relationships are both key to providers willing to improve and expand their services and to cities willing to benefit from them to solve urban mobility issues. Concretely, Firnkorn & Müller (2012) suggested the development of an integrated policy framework for all cities modes of transportation by regulating three main issues for implementing these service on a large scale: land use as parking for carsharing services, public charging stations to charge electric fleets, and the integration with the public transport system. Furthermore, Janasz & Schneidewind (2017) added the necessity of having ICT platform providers and operators, public transport operators, payment operators, and providers of both geo-localization and location-based services. Additionally, Gao & Zhang (2016) included investors, insurance companies, and third party partners, such as partners for recruiting drivers. Other partnerships established by these services include car manufacturers or car rental companies (vehicle providers), fuel or charging distributors, and promotion partners. For instance, Chan & Shaheen (2012) and Herrador et al. (2015) noted that the use of ridesharing was promoted by the partnership between NuRide, public agencies, and others businesses, who together sponsored incentives.

In the case of ride-hailing, which requires drivers and vehicles, either drivers provide their own cars or they are supplied by rental car companies or automakers. However, it is also possible that investors or collaborators provide the service with both skilled/licensed drivers and a fleet of cars.

Münzel et al. (2017) related the type of carsharing provided to the type of partners among German carsharing operators: public transit, city-related partners (municipalities, local utilities, and building associations), and car-related partners (car dealers, and leasing or rental companies). Moreover, the authors studied the backgrounds of owners, ranging from car manufacturers, car rental companies, and car dealers to rail operators and start-ups. In addition, B2C carsharing providers need parking spaces for their cars, and for that reason they need to have partnerships with either private parking operators or local governments, whichever entity is the corresponding provider of regulated on-street parking. Furthermore, one-way carsharing services such as car2go and DriveNow can be found in some airport parking lots. car2go also has a partnership with Lufthansa, who offers at a discount the car2go service in advance as an airport shuttle. Lesteven & Leurent (2016) designed a business model targeting tourists, which required the partnership of different players in this sector, such as hotels, amusement parks, and tour agencies. In the P2P type, individual car owners are the suppliers of the vehicles, being the key partnership in this model.

3.2.9 Cost Structure

All three categories of the analysed mobility services have similar costs, all of them being fixed costs: expenses related to the workforce, software and hardware, research and development activities, infrastructure, vehicles and the associated insurance (if owned by the service) (Lesteven & Leurent, 2016; Hunke et al., 2017), and marketing.

Additionally, B2C carsharing and ride-hailing expenses entail parking and maintenance of the fleet as a variable cost, specifically in regard to fuelling or charging, cleaning, and repairs.

Key Partnerships

- Local governments
- Policy maker
- Public transport services
- Technological platform providers
- Vehicle providers
- Fuel & charging distributors
- Insurers
- Payment operators
- Providers of geo-localisation & location-based services
- Investors
- Promotion partners

Ride-hailing:
- Freelance drivers (P2P)

Carsharing:
- Car owners (P2P)
- Parking providers

Key Activities

- Development, management and optimisation of the technological platform and apps
- Management of reservations, cancellations, payments and contracts
- Customer service
- Marketing & partnerships

Ride-hailing:
- Fleet operation, management and optimisation
- Provide on-demand rides
- Easy and convenient localization of riders and drivers
- Vehicles maintenance (B2C)
- Recruit qualified drivers / Offer flexible jobs to drivers

Ridesharing:
- Connect drivers and riders
- Build trust

Carsharing:
- Fleet operation, management and optimisation
- Provide vehicles on-demand and under reservation
- Easy and convenient localisation of vehicles
- Real-time info of vehicles availability
- Vehicles maintenance (B2C)
- Provide vehicle owners with an efficient platform to rent their vehicles (P2P)

Key Resources

- Vehicles
- Mobile application
- Technological platform
- Digital payment
- Insurances
- Charging infrastructure

Carsharing:
- Fleet managers
- Parking spots
- Digital access technology
- In-vehicle technology

Ride-hailing:
- Skilled drivers
- Licenses: taxi or VTC (if required)
- Driver app
- Routing and matching algorithms
- Pricing algorithms

Value Propositions

- App-based service
- Easy booking
- Cashless payment
- Transparency on prices
- Any time 24/7

Ride-hailing:
- Flexible, convenient, fast and low-cost on-demand rides
- Guaranteed fare
- Singular or shared
- Information of estimated time of arrival, cab position, and driver assigned
- Additional source of income for freelance drivers (P2P)

Ridesharing:
- Enable P2P shared trips
- Pre-arranged or real-time service

Carsharing:
- Car rentals per minutes/hours
- Digital access to a car
- Previous booking or on-demand
- Point-to-point or round-trip
- Variety of car models
- Additional source of income for owners willing to share their car (P2P)

Customer Relationships

- One-off sign-up
- Customer service
- Reputation system

Ride-hailing:
- Social gathering riders/drivers

Channels

- User-friendly app
- Multimodal apps
- Website
- Marketing
- Customer service

Ride-hailing:
- Booking hotline

Ridesharing:
- Park-and-rides
- Transfer hubs
- Companies

Carsharing:
- Parking spots
- Companies

Customer Segments

- Private & corporate customers: occasional/regular urban/interurban
- Public transport users
- Government
- Businesses

Carsharing:
- Neighbourhoods
- Universities
- Tourist locations

Cost Structure

- Personnel costs
- Maintenance of software and hardware
- Research and development
- Marketing
- Cost of the infrastructure
- Insurances

Ride-hailing and Carsharing:
- Acquisition and maintenance of the fleet (B2C)
- Parking (B2C)

Revenue Streams

- Pay per use
- Commission per transaction (P2P)

Ride-hailing:
- Rate per km and/or per min, flat rates
- Surge pricing
- Extra charges for additional services

Ridesharing:
- Subscription fee
- Freemium model (e.g. shops, ads)

Carsharing:
- Registration fee, monthly fee
- Day, hour or min. fee
- Rate per km
- Additional fees for: special destinations, premium car models, extended reservations
- Sponsorship and advertising

Figure 8. Summary of the key features of car-related shared mobility services per building block.

3.3 Discussion and Conclusions

In the majority of building blocks, we found more similarities than differences among the analysed services. After comparing the different business models, we detected that these services are complementary rather than interchangeable, since they all cover different needs.

Accordingly, from the literature and the interviews analysis we identified that car-related shared mobility services can be classified depending on the type of request (a ride or a car), the type of use (occasional or regular), and the trip distance (urban or interurban). Table 3 uses this classification to categorise the best service for each use case or customer need. For urban uses, the most suitable services are ride-hailing or one-way carsharing –which enable users to return the vehicles near their destinations at specific points (station-based) or directly on the streets (free-floating or flexible)–, since both types offer on-demand and easy access to a ride or a car. Considering their revenue streams, they are suitable for first and last mile trips, but not for those interurban. Instead, the round-trip model is a more suitable choice for interurban travels. Moreover, the P2P model might cover better occasional requests, whereas the B2C round-trip model is better for frequent users, since their operators usually offer subscription plans. On the other hand, for commuting or long distance trips, either occasional or regular, the most used service is ridesharing, since it is the most cost-effective option for the users.

Table 3. Classification of for-profit car-related shared mobility services according to customer needs.

Type of request	**Type of use**		**Trip distance**		**Proposed service**	**Examples**
	Occasional	**Regular**	**Urban**	**Interurban**		
Ride	x		x		Singular ride-hailing	Uber, Cabify
		x	x		Shared ride-hailing	Via, CleverShuttle
	x	x		x	Ridesharing	BlaBlaCar, Amovens
Car	x	x	x		B2C one-way carsharing	car2go, DriveNow
		x		x	B2C round-trip carsharing	Zipcar, Respiro
	x			x	P2P round-trip carsharing	SocialCar, Drivy

By analysing each building block of the BMC, we also noticed that the targeted Customer Segments are complementary, since each type of service offers a different Value Proposition to cover the different user needs. This way, commuters may use a shared ride-hailing or a ridesharing service to commute, but also a singular ride-hailing service for leisure trips and a carsharing service for a day trip. Therefore, if services could be provided in a combined and integrated way, the value created for the targeted Customer Segments would be higher, being the most appreciated the possibility of accessing any service through the same access point: one registration, one app, and one customer service. Furthermore, the analysis of the Value Proposition proves that ride-hailing, ridesharing, and carsharing have similar characteristics in that they are app-based and offer easy booking and access to the service (convenience), as well as cashless payment (convenience), and firm price quotes (price). The main reason to use these services according to our surveyed users was the convenience (49%), the price (23%), and to test it (14%).

The majority of the characteristics in the Channels and Customer Relationships blocks are common to the three studied types of services: all need a user-friendly app, a website, and marketing actions to deliver the Value Proposition. In addition, they all want to establish a comfortable and convincing relationship with the customer, doing so in ways that range from requiring only a single registration up to offering a reputation system for improved customer service. This way, providers offering more than one service together could cut costs optimising these actions, since they could be merged. Regarding the Revenue Streams, these services are accessible through pay per use, but other revenue models could be also applied. For instance, shared mobility services could be sponsored, they could generate business with the data, or new car-related services could be offered, such as parcel delivery. Common Key Resources are vehicles and mobile applications, the technological platform, digital payment, and insurances. However, ride-hailing also requires skilled and licensed drivers, and routing and matching algorithms, while carsharing requires parking spots, in addition to, desirably, digital access and in-vehicle technology. Common Key Activities are the development and optimisation of the platform and the corresponding apps and algorithms, as well as the management of reservations, cancellations, payments, and contracts. The differences are related to the particular service features, with ride-hailing and carsharing needing to operate and manage a fleet, keep it clean and properly serviced, and to locate drivers, riders, and vehicles in real time. According to Kahlen et al. (2017), the optimal prepositioning and relocation of vehicles is the key to optimise the fleet size and maximise the revenues of ride-hailing and one-way carsharing services. Moreover, ride-hailing recruits drivers whereas P2P carsharing recruits cars to rent. Concerning Key Partnerships, the only differences are that P2P ride-hailing creates partners with freelance drivers, P2P carsharing creates partners with car owners, and B2C carsharing creates partners with parking providers. Common Key Partnerships are: local governments and public transit, ICT platform providers and operators, payment operators, investors and promotion partners, and providers of vehicles, fuel or energy, insurances, and geo-localisation and location-based services. Finally, the Cost Structure is also very similar, having in common personnel costs, software and hardware maintenance, research and development activities, infrastructure, and marketing; while they differ in that they have acquisition and maintenance costs of their fleet (B2C ride-hailing and B2C carsharing), and parking costs (B2C carsharing). Therefore, the Cost Structure, as well as the Key Partnerships, Key Resources, and Key Activities could be optimised if companies provide these services in an aggregated form.

In the market, we find some operators offering two mobility services from the same application: Uber and Lyft combine the offers of singular and shared ride-hailing, Amovens provides a combined offer of ridesharing and P2P carsharing, and Cabify of ride-hailing and B2C carsharing, this last option enabled through a partnership with the car rental Bipi. These services share the app, the technological platform, Channels, Customer Relationships, and Key Partnerships, but they could be optimised if they would also share the Customer Segments, the vehicles, and the fleet management. To make progress on the basis of providing an integrated service, we only found ReachNow in United States, which offered, until July 2019, carsharing and ride-hailing using the same vehicle fleet: users could rent the cars through the carsharing offer and use them to organise ride-hailing trips as drivers.

From a business point of view, the main advantages for a mobility provider in offering several services in an integrated way would be: 1) higher utilisation of the vehicles, since it targets different uses. Also, this integration would enable providers to size and optimise the fleet dedicated to one or another service depending on the predicted demand. For instance, carsharing might have higher use at weekends or on public holidays, but ridesharing and shared ride-hailing during peak hours any day of the week, and singular or shared ride-hailing at night or to go back and forth from big events; 2) optimisation of the technological platform and related development activities, as well as fleet management and marketing activities; and 3) the increase of customer loyalty, since they would no longer need more than one app to access different services. On the other hand, relevant drawbacks that would prevent operators offering their services in an aggregated way would be: 1) the rise of the service management complexity, due to the real-time dimensioning and relocation of the fleet activities, and the provision of chauffeurs when required; 2) the increase of the cost structure if drivers are hired for providing ride-hailing services, although this cost would disappear with autonomous vehicles; and 3) regulatory issues, which differ between countries and even between regions and cities in the same country, and which could complicate the proposition and implementation of the service.

Another solution to help improve the profitability of mobility providers would be to outsource some key activities to third parties, who could offer the same service to other providers, reducing the cost of these activities. Alternatively, agreements between providers could be established to enable activities to be shared among their services. In this sense, the most relevant activities to outsource or to be provided or shared with other providers would be the customer service and those related to technology (development, management, and optimisation of the platform and applications) and operations (maintenance and fuelling/charging of vehicles). Going further in a conceptual partnership between mobility providers, some key resources could also be provided to, or received from, these partners, who in some cases might be competition. For instance, unused and non-reserved vehicles and parking spots.

Focusing on ride-hailing, and taking into account that drivers are the highest cost ride-hailing service providers sustain, it might be helpful that these providers could share the same drivers, i.e. the drivers could work at the same time for more than one service. Some drivers are currently working for more than one operator (e.g. Lyft and Uber) in several cities. However, in a number of countries this might not be directly allowed, but might be enabled through outsourcing the driving services to a third company. The main risk identified in these cases, which involve a certain degree of collaboration with the competition (direct or indirect, i.e. same or different type of service offered), is the loss of the differentiation and uniqueness, leading to confusion.

After this analysis, we detect the need to focus the research on the following three lines:

- Study of the usage intention of the different shared mobility services according to gender, age, or use case, among other factors. This will enable us to identify the most suitable service for different situations and detect whether an aggregated service would be reasonable from the users' point of view.

- In-depth analysis of the shared ride-hailing service and the commuting use case. On one hand, the reason to study the commuting use case is twofold: 1) due to the traffic linked to it, and therefore, the potential that shared mobility services have to reduce it; and 2) because commuters would be frequent users, making at least 2 trips per day. On the other hand, we choose to focus on shared ride-hailing since, apart from being the least studied service, it is the service with the highest potential to maximise the benefits of cities, users, and operators.
- Identification of opportunities and limitations in the implementation of aggregated services and services with additional uses (i.e. technical feasibility and regulatory issues).

Chapter 4. ANALYSIS OF MOBILITY PATTERNS AND INTENDED USE OF SHARED MOBILITY SERVICES IN THE BARCELONA REGION

According to literature, new mobility services should merge benefits offered by owning a car, in terms of convenience, freedom, control, comfort, and flexibility, and the positive aspects of public transportation, for instance, affordability, efficiency, and sustainability (Hietanen, 2017; Villalante, 2017; UITP, 2017; McKinsey&Company, 2015; EY Global Automotive Center, 2013; Fishman, 2012; Okuda et al., 2012). Furthermore, all authors believe in multimodal and integrated services with the public transport offer, evolving to the MaaS model.

The aim of this chapter is to study the usage intention of shared mobility services by inhabitants of the metropolitan Barcelona region, relying on a quantitative analysis of their mobility patterns, behaviours, needs, and expectations.

The chapter is organised as follows: first, we introduce the case study and the methodology used to conduct the research. Then, we present the results of the quantitative analysis, highlighting the differences among customers regarding factors such as their age, accessibility to cars, and daily trip type. To finish, the discussion and conclusions are provided.

4.1 CASE STUDY AND METHODOLOGY

On a working day, more than one million vehicles enter and leave the city of Barcelona (Barcelona City Council, 2018). This city, with 1,620,809 inhabitants and an extension of 102.2 km^2, receives daily a number of work-commuters equivalent to almost 20% of its population, whereas 74.5% of its employed population stays to work in the city (Barcelona City Council, 2018).

Although within the Metropolitan Region of Barcelona (RMB) –with a population of 4,841,365 and an area of 3,236 km^2 distributed among 164 municipalities (Metropolitan Territorial Planning Commission of Barcelona, 2010)– mobility for personal reasons is considerably higher than occupational mobility, whereas 52.3% of trips for personal reasons are taken on foot and by bicycle, 15.3% by public transport, and the remaining 32.4% by private vehicles, commuting is mostly by car: 49.6% of commuting trips are taken by private cars and motorbikes, 30.4% by public transport, and the remaining 19.9% by non-motorised means (IERMB, 2018).

The high use of non-motorised transport for personal mobility is very common in dense cities, since travel distances tend to be shorter (Kenworthy, 2006). According to a Eurostat study, the RMB is the 6th largest urban area in the European Union, behind London, Paris, Madrid, Ruhrgebiet and Berlin (Koceva et al., 2016). This study also indicates that this region records two of the three highest levels of population density in the EU-28. The highest ratio is located within l'Hospitalet de Llobregat –with

53,119 inhabitants/km²– and the third highest ratio within Badalona –with 50,287 inhabitants/ km²–, behind the 18th arrondissement in Paris (52,218 inhabitants/km²) (Koceva et al., 2016).

Regarding new mobility services operating in Barcelona, at the time this quantitative study was conducted (January 2017), we found: mytaxi, which is a taxi-hailing service; Cabify, which is a singular ride-hailing service operating in the city with VTC licences; Zipcar (under the brand of Avancar) and Bluemove, both B2C carsharing companies; SocialCar, Drivy, and Amovens, the three of them offering P2P carsharing services; and the B2C electric scooter sharing services eCooltra[30], Yugo[31], Motit[32], Muving[33], and Outo[34] –Outo also offering P2P scooter sharing–.

With the aim of finding out about the mobility patterns, behaviours, needs, and expectations of the inhabitants of Barcelona and of RMB, a quantitative study was conducted between the 17th and 27th January 2017. A total of 602 interviews were carried out through a Nicequest[35] web panel. Quotas for gender, age, and origin and destination of daily trips were used to obtain similar distributions in the sample for better comparison with each other.

The questionnaire applied was structured with closed questions (see appendix A). The survey asked 12 questions regarding the intention of use of shared mobility services as well as the preferred options according to different types of trips, price setting, and accessibility to these services. Furthermore, 8 classification questions and 3 questions regarding the usual means of transport and the reasons for their use were also requested. Figure 9 shows the structure of the conducted survey.

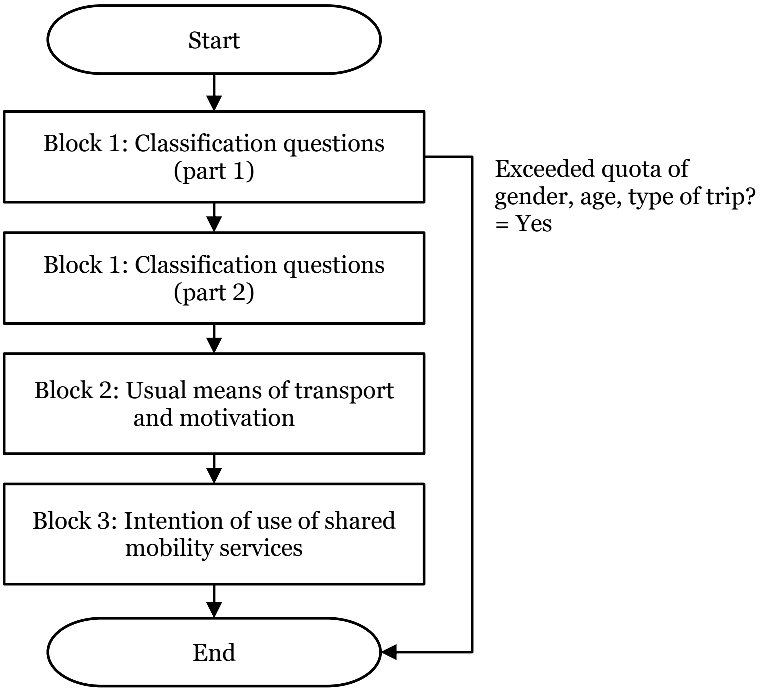


Figure 9. Structure of the questionnaire of the RMB case study.

[30] For more info, see: https://www.ecooltra.com
[31] For more info, see: https://www.getyugo.com
[32] For more info, see: http://www.motitworld.com
[33] For more info, see: https://muving.com
[34] For more info, see: https://www.outo.es
[35] For more info, see: https://www.nicequest.com

4.2 Analysis of results

This subsection discusses the outcome of the survey. First, the respondents' profile is provided as well as their mobility patterns, which are analysed by age, gender, location, and employment situation. Then, the analysis continues with the use intention of the emerging mobility services studied, being aware of the limitation that most of the interviewees had never used a shared service before –bike sharing included–. Therefore, during the survey all services valued where in every question explained in detail and with examples.

4.2.1 Participants' profile and mobility patterns

The respondents' profile is described in Table 4. Due to the definition of a sample profile, a similar participation rate among genders and ages was obtained. Most of the participants were employed, had university studies, had a driving license, and owned a car. Concerning their mobility patterns in a normal working day, 48.3% travelled within Barcelona or its neighbouring municipalities (Badalona, Sant Adrià de Besós, Santa Coloma de Gramenet, L'Hospitalet de Llobregat, El Prat de Llobregat, and Cornellà de Llobregat), 24.9% from Barcelona or its immediate vicinity to other locations of the RMB, and the remaining 26.7% from the RMB to Barcelona and vicinity.

Table 4. Respondents' profile of the RMB case study.

Question	Stated answers	No. of responses
Gender	Men	302
	Women	300
Age	18-29	202
	30-45	200
	+45	200
Driving license	Yes	523
	No	79
Car at disposal	Yes (owner)	402
	Yes (access)	96
	No	104
Regular trips' origin	Barcelona	344
	Neighbouring municipalities	168
	RMB	90
Regular trips' destination	Barcelona	354
	Neighbouring municipalities	172
	RMB	76
Occupation	Employed	447
	Students (exclusively)	51
	Students (also working)	42
	Unemployed	27
	Retired	0
	Declined to respond	*35*
Monthly incomes	Up to 700€	13
	701€ to 1,200€	59
	1,200€ to 2,000€	130
	More than 2,000€	229
	Without monthly incomes	11
	Declined to respond	*160*

According to the analysis of the questions regarding having a driving license and access to a car by monthly incomes, it was found that the profile with more access to driving a car was directly related to the level of income and inversely proportional to the use of public transport. Additionally, responses to *"Which means of transport do you use to travel in a normal working day?"* led to the conclusion that 53.5% of interviewees used more than one mode of transport every day, being the inhabitants with the lowest incomes the most multimodal (they would not always take the same means of transport to reach the destination) and intermodal (they would use more than one mode during one trip), with the exception of the unemployed population. Accordingly, Table 5 provides an overview on the mobility patterns of respondents by employment situation. The first column shows the percentage of respondents of each category over the total answers. Next, each row gives the percentage of affirmative answers over the respondents of each category. From this table, it can be seen that the segments with more use of public transport were students and unemployed residents. Students were the most multimodal and intermodal, with a rate of up to 72.6%, and those with the most limited access to a car (54.9%). Although it should be noted that the proportion of students and unemployed inhabitants from the sample is very small (ratio of students exclusively and also working: 8.5% and 7% respectively, ratio of unemployed respondents: 4.5%).

Table 5. Classification of the mobility behaviour by employment situation.

Employment situation	**n**	**Have a driving license**	**Access or owners of a car**	**Daily users of public transport**	**Daily multi-inter-modal users**	**Users of shared services**
Employed	74.2%	92.2%	86.8%	58.4%	51.%	32.9%
Unemployed	4.5%	81.5%	74.1%	74.1%	44.4%	18.5%
Student (also working)	7.0%	78.6%	73.8%	76.2%	64.3%	50.0%
Student (exclusively)	8.5%	45.1%	54.9%	96.1%	72.6%	35.3%
Decline to respond	5.8%	94.3%	88.6%	57.1%	51.4%	34.3%

Age analysis revealed that the 30-45 age segment had almost identical mobility behaviour as the +45 age segment, except for the use of shared services (Table 6). Again, the first column shows the percentage of people from the sample that belongs to each category. Comparing both segments with the 18-29 age group, we appreciate that the percentage of respondents with a driver's license and access to a car is 20 points higher in the older age groups. In contrast, the youngest segment used public transport up to 26.7% more and were 20.3% more multimodal and intermodal.

Table 6. Classification of the mobility behaviour of respondents by age.

Age	**n**	**Have a driving license**	**Access or owners of a car**	**Daily users of public transport**	**Daily multi-inter-modal users**	**Users of shared services**
18-29	33.6%	73.3%	70.3%	81.2%	66.8%	44.1%
30-45	33.2%	94.0%	89.5%	54.5%	46.5%	38.0%
+45	33.2%	93.5%	88.5%	54.5%	47.0%	19.0%

Between genders, as shown in Table 7, the major difference was with the use of public transport, since women used public transport on a daily basis up to 17% more than men (72% versus 55%). According to Figure 10, the difference regarding the use of public transportation by gender is greater when inhabitants travel out of the city. Although both genders had a much more extensive use of public transport for moving within the city, women, unlike men, almost kept this level of use for trips to the RMB (73.1% vs. 48%).

Table 7. Classification of the mobility behaviour of respondents by gender.

Gender	N	Have a driving license	Access or owners of a car	Daily users of public transport	Daily multi-inter-modal users	Users of shared services
Men	50.2%	91.1%	86.7%	55.0%	50.0%	35.8%
Women	49.8%	82.7%	78.7%	72.0%	57.0%	31.7%

In relation to public transport, as shown in Figure 10, it was considerably more used by the residents who travelled within Barcelona and its vicinity (BCN-BCN) than the ones who travelled to other locations of the metropolitan region (BCN-RMB), or entered the city from the RMB (RMB-BCN).

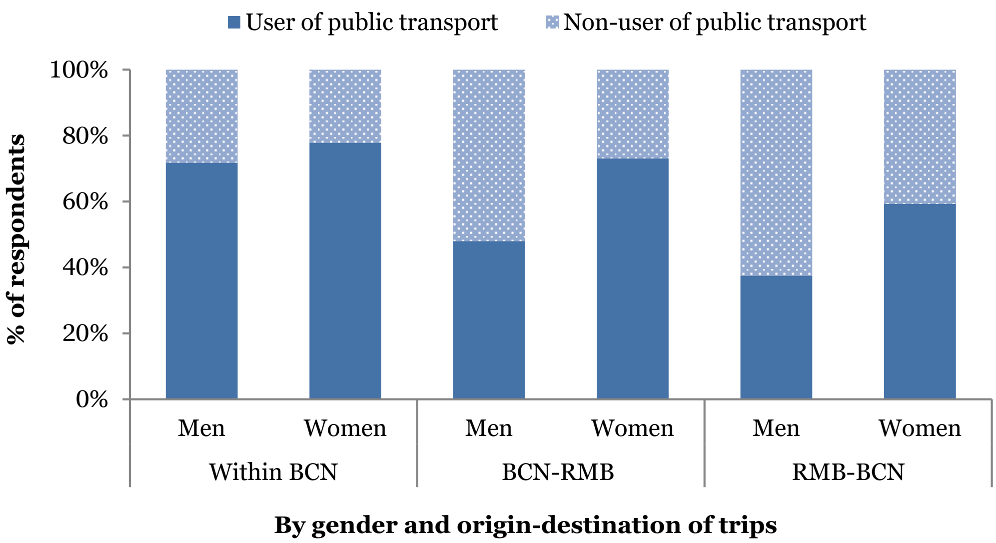


Figure 10. Use of public transport by gender and origin-destination of the trips.

As shown in Figure 11 –note that the results presented come from a multiple choice question–, the public transport most frequently used was the underground –both for inhabitants travelling within Barcelona and vicinity (62.9%), and for those who enter or leave the city (42.7% and 34.2% respectively)–, followed by the regular bus –with also a greater use of the city's internal travellers–. As for the train, logically, the highest use comes from trips with origin or destination outside the city, although its use is substantially lower than that of the car. The two companies operating in the RMB were considered: RENFE and FGC. On the other hand, over half of the interviewees who left or entered the city of Barcelona or its neighbouring municipalities used the car on a daily basis (50.7% and 62.1% respectively), whereas participants who moved within the city used it with a rate of 28.5%. It is also noteworthy that the use of motorbikes and bicycles for trips within the city was quite similar (15.1% versus 12.7%).

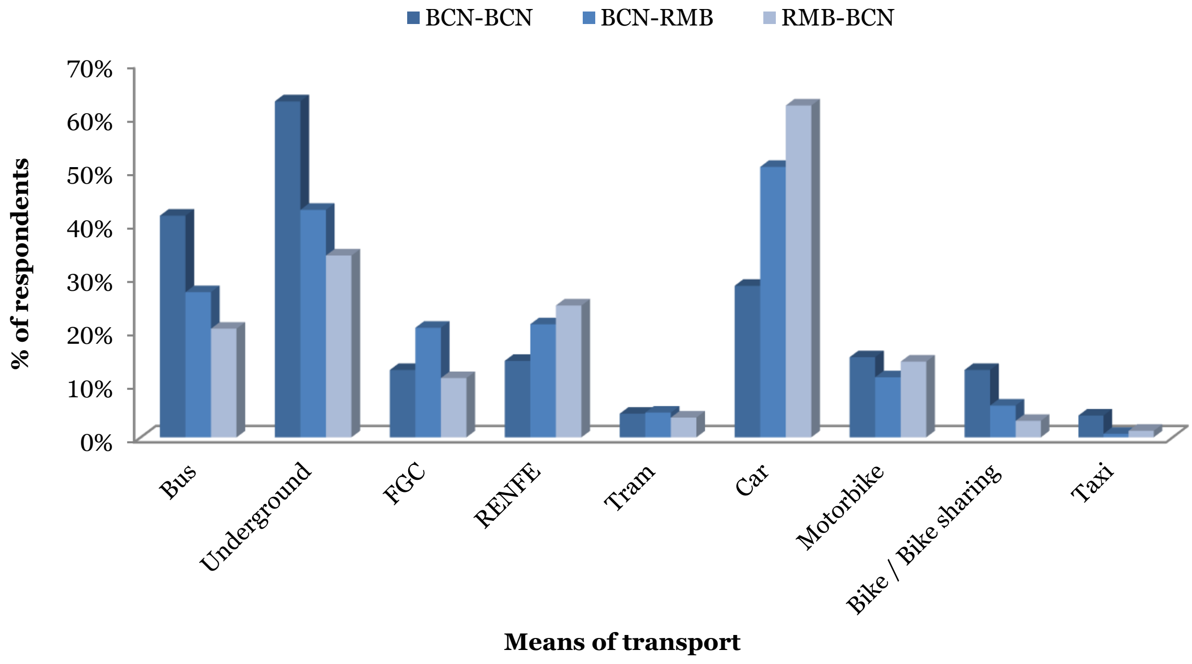


Figure 11. Responses to *"Which means of transport do you use to travel in a normal working day?"* classified by origin-destination of the trips.

According to the interviewees, the main reasons to use public transport (excluding the taxi) were the stop proximity of the departure point or destination (specially for the bus), to avoid commuter traffic (in particular with the use of the underground and the train), and also due to being affordable and sustainable. In contrast, the main reasons to use the private transport –car and motorbike– were the availability of parking near the destination, speed, and provision of a direct connection to the destination. Figure 12 compares the importance of different reasons by which users used each of these means of transport on a working day.

In relation to the public means of transport, it is observed in Figure 12 that: the bus and the tram were also used for comfort, the bus for providing a direct connection to the destination and for breaking the daily routine, the underground and the train for being fast, and the underground, also, for being punctual. Furthermore, all public transport means were also considered safer than private means. As for the taxi, the main reasons for its use were comfort, enabling users to easily modify their routes, speed, and for facilitating the carrying of luggage.

Regarding the use of the private bicycle or bike sharing, users valued the sustainability of this mode, the low cost, and that it enables breaking the daily routine, modifying the route, and parking near the destination. As for the motorbike, users used it because they could park near the destination, and for being fast and able to easily modify the route. And, concerning the car, their users chose this mode for being comfortable and able to park near the destination, for being fast, because it provided a direct connection, and for the ease of carrying luggage and modifying the route.

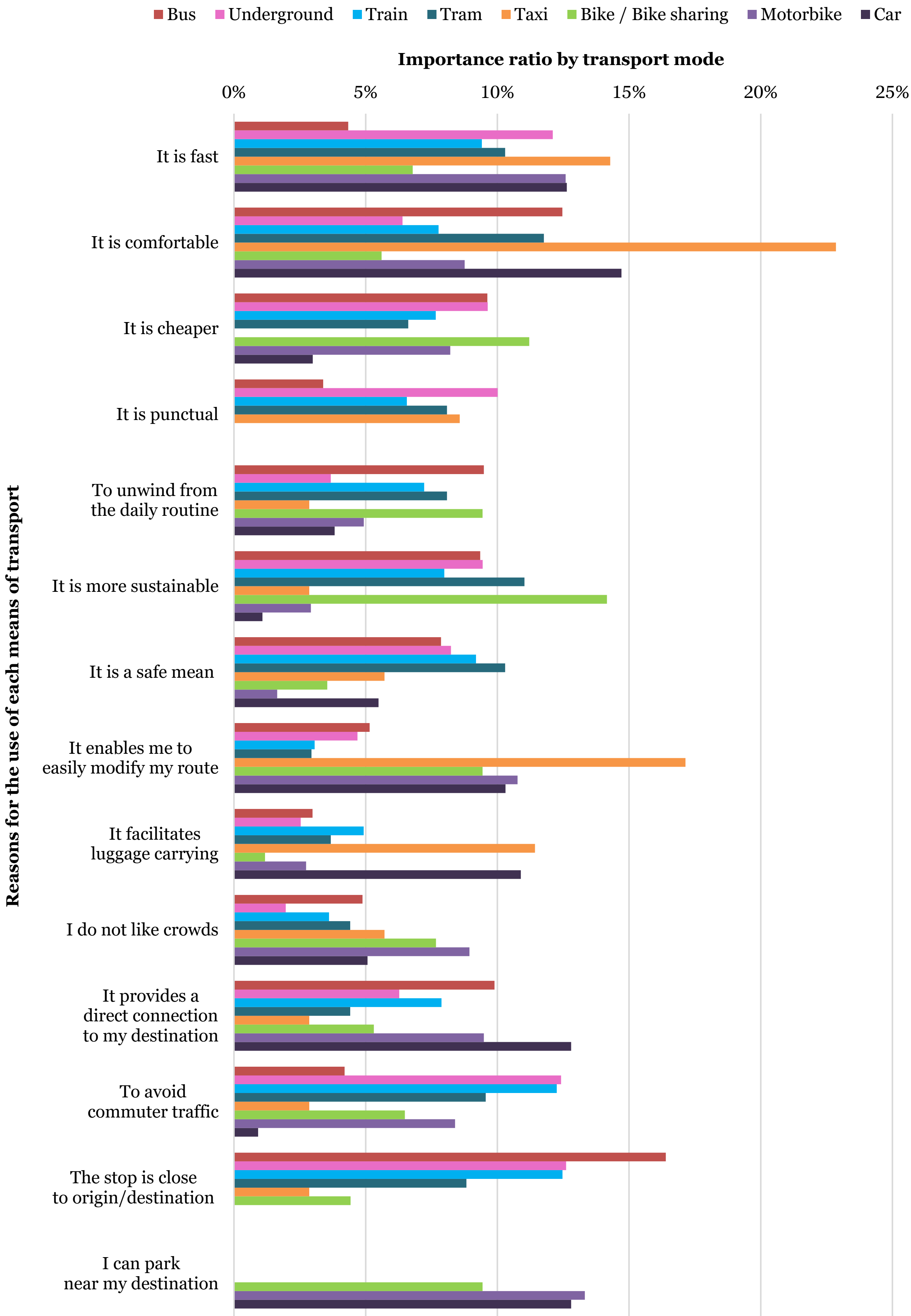


Figure 12. Responses to *"For which reasons do you use each of these means of transport to travel on a working day?"*, classified by the reasons provided.

On the other hand, the arguments of non-users of public transport to not take this mode were, mainly, due to its unavailability in their origin or destination and to inadequate connections. Other not so emphasised reasons were the discomfort, that they preferred to travel by car or motorbike, or that transfers were required.

Table 8 classifies the surveyed inhabitants depending on their use of public and private transport. From this table it is noted that, overall, more than 20% of respondets needed to not only use of their private vehicles but also to take the public transport to reach their destinations. This is probably due to the fact that using the private vehicle during part of the trip was faster than only using public transport, but using the private vehicle until the destination was more expensive in terms of money or time (e.g. need of parking).

Table 8. Daily transport by type of origin-destination of the trips.

Daily transport	BCN-BCN	BCN-RMB	RMB-BCN
Only users of public transport	47.8%	35.3%	26.7%
Only users of private transport	24.7%	43.3%	51.6%
Users of public and private transport	27.5%	21.4%	21.7%

Regarding the use of shared mobility services, 66.3% of interviewees had never used either a vehicle sharing service (i.e. carsharing, scooter sharing, and bike sharing) or a ridesharing service, 20.1% had used only one type of these services, and the remaining 13.6% had used more than one type. As reflected in Figure 13, the most popular mobility service among respondents was bike sharing (20.6% had used Barcelona's public bike sharing service: Bicing), followed by ridesharing (14.6% had tried BlaBlaCar), carsharing (6.4% had taken Avancar and 1.8% SocialCar), and scooter sharing (2.5% had used eCooltra, 0.8% Yugo, and 0.5% Motit) –notice that these results come from a multiple choice question–. Among users of shared mobility services, no difference was observed from a gender perspective, but the behavioural difference between generations was noticeable. Only 19% of participants older than 45 years had tried this type of services, whilst 38% of participants aged 30-45 and 44% of participants aged 18-29 had used them (Table 6). The most valued aspect of these services was that they are cost-saving and the least valued aspect was the limited availability.

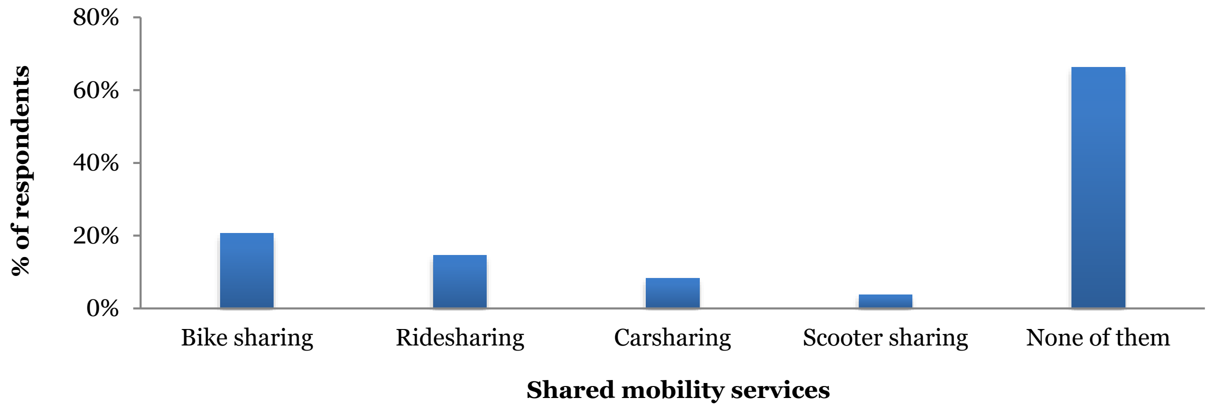


Figure 13. Responses to *"Which of the following services have you used at least once?"*.

Considering the results presented in this subsection, it can be assumed that the mobility behaviour of the population changes according to age, gender (except for the use of shared mobility services), type of trip, and employment situation. The youngest population stood out for their use of public transportation, use of shared services, and for being more multimodal and intermodal, featuring a similar behaviour as students –notice that 94.6% of surveyed students were aged 18-29–. Between genders, women travelled more by public transport than by car, whereas men elected the car more often, exception being trips within the city.

4.2.2 Usage intention of shared mobility services

Interviewees expressed their intention of use of different shared mobility services considered in the survey on a scale of 1 to 7: being 1 the lowest rate *"Will definitely not use it"* and 7 the highest *"Will definitely use it"*. As shown in Figure 14, the histograms reflect that the highest use intention (sum total of answers 5 to 7) favoured B2C carsharing, followed by singular ride-hailing, ridesharing, shared ride-hailing, and P2P carsharing.

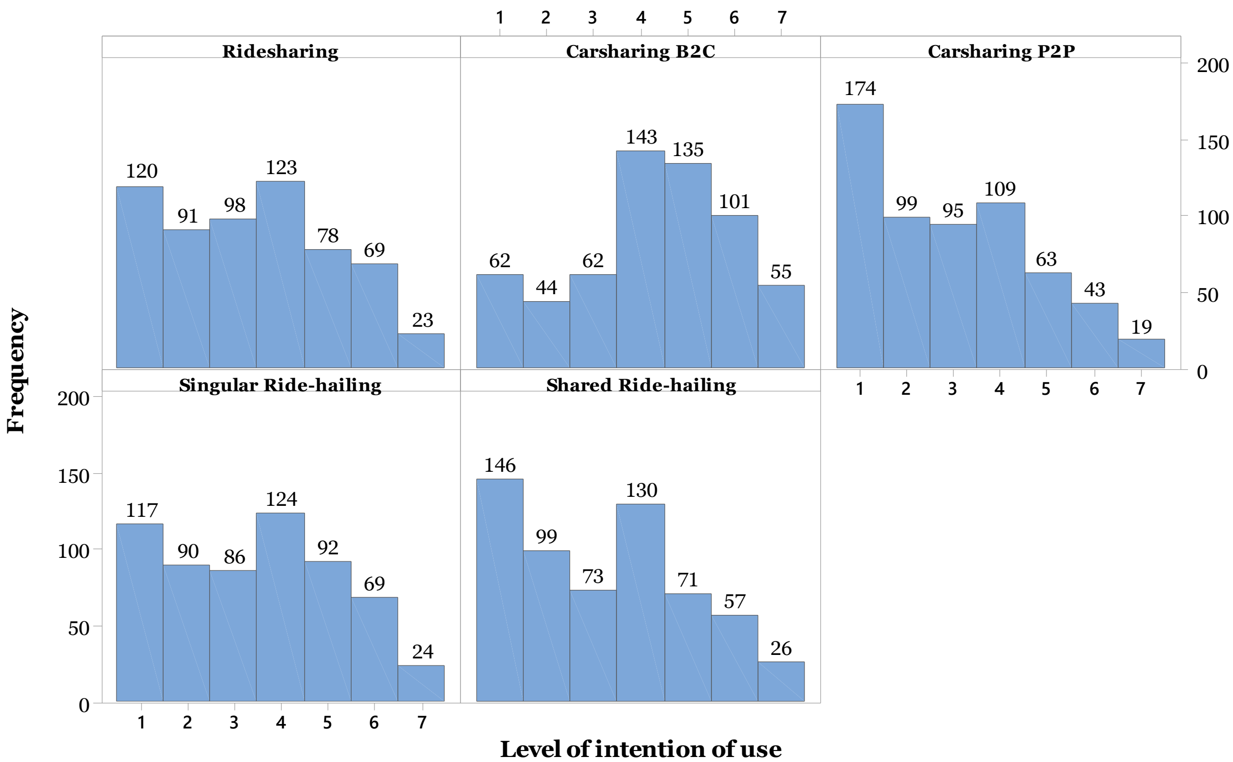


Figure 14. Responses to *"If these services were available, to what extent would you be willing to use them?"*.

With regard to statistics, the medians obtained in all cases (general analysis, study by gender, age, previous experience, and type of trips) are similar enough to their related means, thus indicating that the data analysed has a symmetric distribution with respect to the arithmetic mean. The highest median achieved was for the B2C carsharing and singular ride-hailing (4), which indicates a positive mind-set towards its use, whereas the other services obtained a median of 3. These results were common to all age groups and genders. As evidenced, the medians obtained revealed a predominant attitude of uncertainty, possibly associated with lack of knowledge or user experience. In fact, respondents with a previous experience in any shared mobility service reflected a greater willingness to use them than inexperienced respondents. The analysis of the mode provides, on one hand, the outcome of *"will definitely not use it"* as the most common intention of use of the different services by previous non-users, with the exception of B2C carsharing, which achieved the result of indifference. On the other hand, previous users of shared mobility services noted indifference to most of the services except for the B2C carsharing and ridesharing, in which the intentions of *"will maybe use it"* and *"will probably use it"* were achieved, respectively.

As represented in Figure 15, age differences were not as significant as having a previous experience with the services studied. Although in each service the medians are identical for the different age groups, the boxplots indicate small variances in the tendencies, meaning that young populations were more predisposed to use ridesharing, P2P carsharing, and shared ride-hailing; whilst the oldest segment was more predisposed to use B2C carsharing.

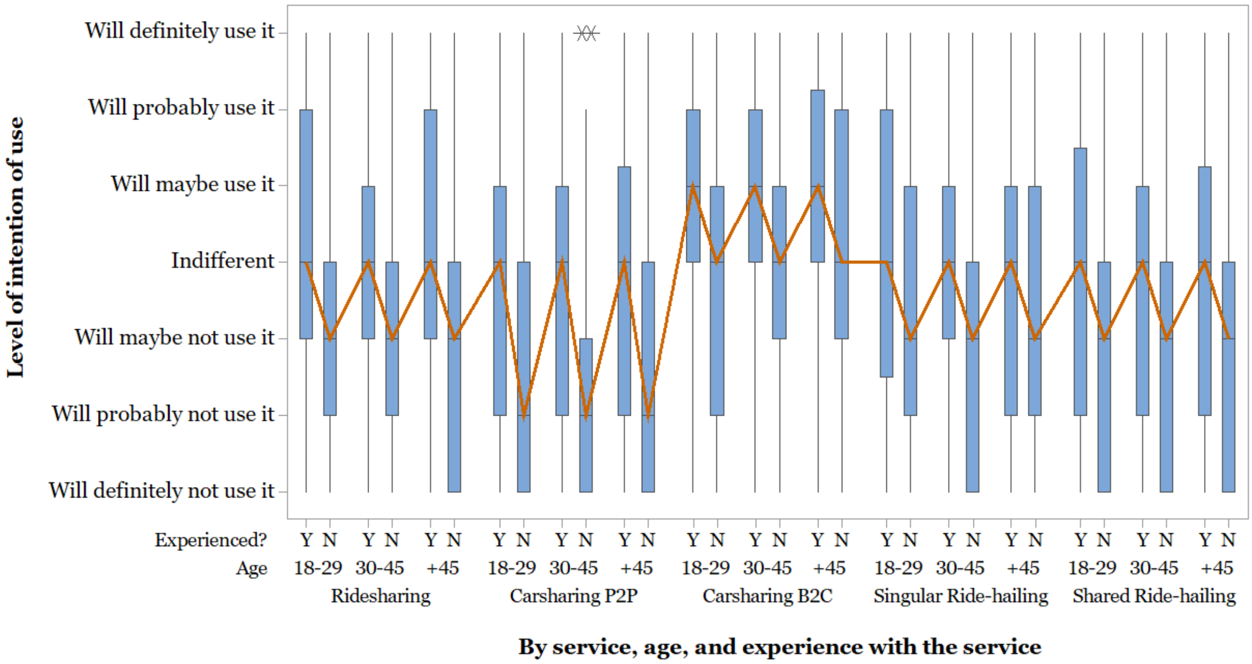


Figure 15. Boxplot of the usage intention of shared mobility services by age and previous experience.

Concerning the intention of use between genders, it was almost identical in relation to the different shared mobility services studied. On the contrary, the analysis by the type of daily trips revealed that participants travelling within Barcelona were more willing to use all of these services than the other participants and that the group less predisposed were the participants who used to travel from the RMB to Barcelona. Probably due to a lack of knowledge of the services –by not having them in their towns– or because they see them as exclusive services of the big cities and do not imagine how and why they could use them. As shown in Figure 16, these results were also connected to the previous experience with shared mobility services of interviewees, since only 16.2% of interviewees who used to travel from the RMB to Barcelona had this experience, whereas 41.9% of participants daily travelling within Barcelona and 36.7% of participants who used to travel from Barcelona to the RMB had previously used shared mobility services.

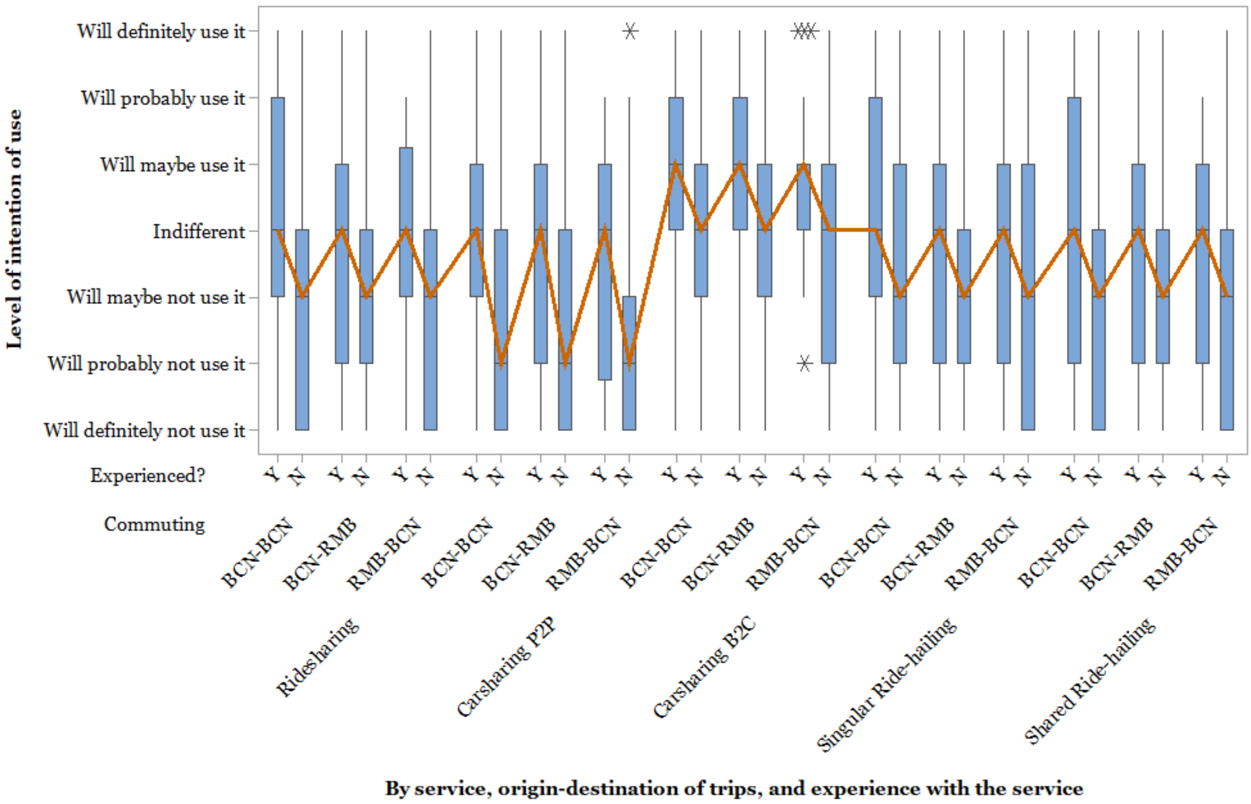


Figure 16. Boxplot of shared mobility services usage intention by origin-destination of trips and previous experience.

Anticipating the possibility of a widespread disregard and lack of knowledge, a separate analysis of each mobility service was conducted.

Ridesharing

One-fifth of respondents would use a ridesharing service for long distance journeys if the cost of the journey was half or less than the cost of travelling by train or by private car. To the question *"Which of the following options would you use for long distance trips (i.e. more than 150 km)? High speed train (30€) - Regional train (21€) - Private car (28€) - Ridesharing (11€)"*, the preferred options were, in general, travelling by high speed train (37.4%) and by private car (27.6%), and the least chosen option was using the regional train (16%). However, the usage intention of ridesharing by existing users of shared mobility services was 8.3% higher than that of non-users, preferring this service to car travel (24.6% versus 21.6%). Surprisingly, the age group most willing to use ridesharing was the oldest, as shown in Figure 17, whereas the youngest prefers the regional train and considerably less the private car. Furthermore, before choosing a ridesharing service, 63% of those interviewed would take into account the opinion of other users in relation to the matched drivers.

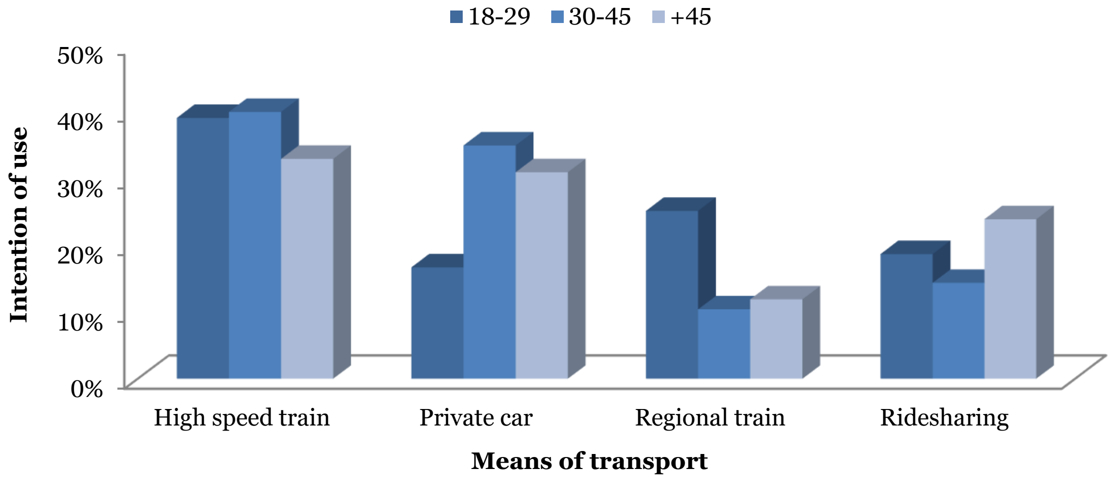


Figure 17. Usage intention of ridesharing for long distance trips, by age and compared to other means of transport.

Carsharing

Two-fifths of respondents (39.7%) would use a carsharing service for a one-day out of city trip if they would not have their own car, preferring a B2C service than a P2P. These results come from the question *"In case of not disposing of a car, which of the following options would you find more appropriate for a one-day out of city trip (i.e. 100 km round-trip)? The current public transport network - Taxi (130€) - B2C Carsharing (2.5€/h) - P2P Carsharing (38€) - Ridesharing (20€)"*. Age analysis revealed that the population aged 30-45 and over 45 years preferred up to 20% more carsharing than the 18-29 year olds (Figure 18). In this context, the youngest group would rather use up to 18% more any public transport than the population older than 30 years.

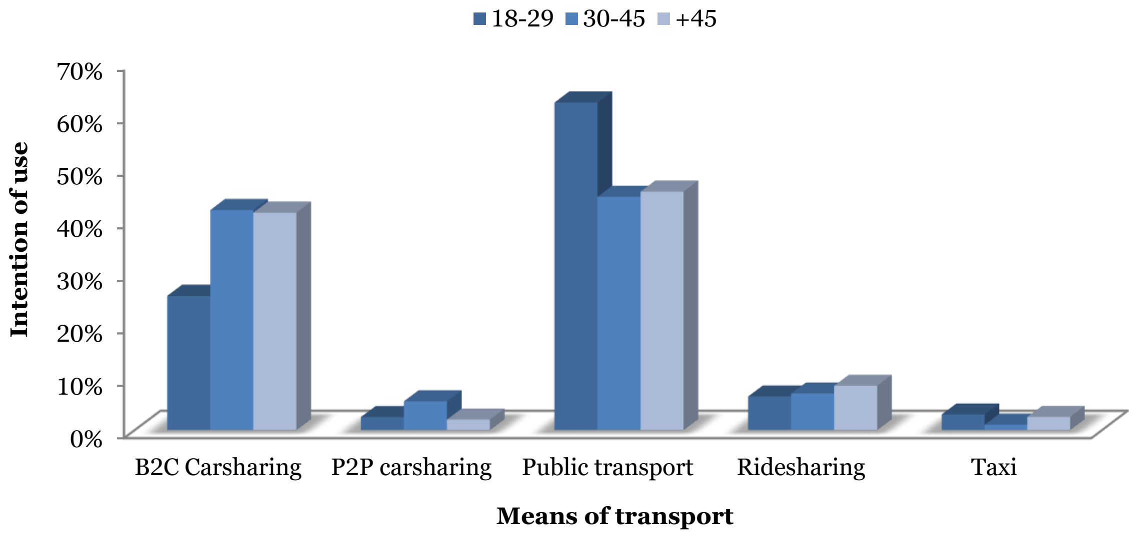


Figure 18. Use intention of carsharing for one-day out of city trip, by age and compared to other means of transport.

When asked about their preferences for the one-way or the round-trip carsharing, 50.8% marked the round-trip option, whilst 42% liked both options, and only 7.2% voted for the one-way. Moreover, only one-fifth of respondents would rent their own vehicles (P2P carsharing), but again this proportion changes depending on the previous knowledge, increasing up to 37% if respondents already had a prior experience using any shared mobility service.

Ride-hailing

On average, respondents would prefer to take a taxi rather than a singular or shared ride-hailing for travelling short distances within the city (31.4% versus 9% and 28.1% respectively) when neither public transport nor private car are considered. The remaining 31.5% of respondents would use carsharing. In this context, the top choice of the youngest was shared ride-hailing, with a rate of 34.2%, as reflected in Figure 19. Figure 19 classifies by age the responses to the following question *"When the private car is not available, and considering that the point of origin and destination do not have a good connection with the underground or the bus, which of the following options would you use for a trip of 10 km within the city? Taxi (15€) - Singular ride-hailing (13€) - Shared ride-hailing (5€) - Carsharing (2.5€/h)"*.

All age groups agreed that for distances of 10-20 km shared ride-hailing was better than the taxi, singular ride-hailing, and carsharing. In addition, the youngest would not mind walking up to 6 minutes to the pick-up point, whilst the other age segments preferred a door-to-door service.

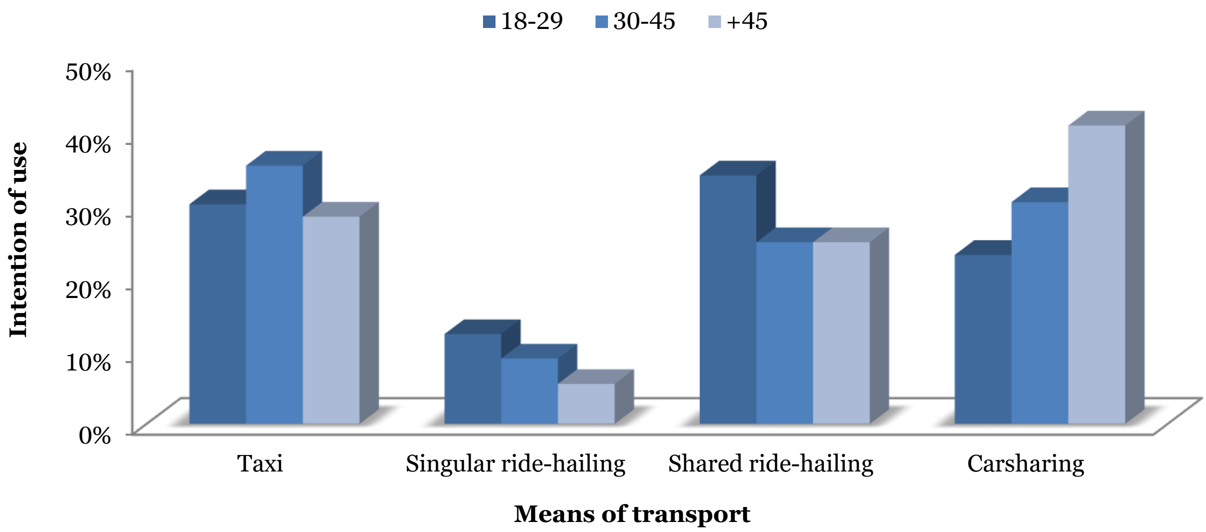


Figure 19. Usage intention of ride-hailing for short trips within the city, by age compared to other transport services.

Cost of the service and payment

Concerning the cost of a carsharing service, participants would prefer to pay for the distance travelled (34.4%) or to have a pass in which minutes or kilometres could be charged in advanced at a lower cost (31.6%), rather than paying for the time of use (19.9%) or for an unlimited monthly travel subscription (14.1%).

Paying for the distance travelled is also preferred in the case of singular and shared ride-hailing services, according to 42.5% of respondents; whilst 30.9% would prefer to pay a fixed price per zone, 18.6% would buy a prepaid card, and only 8% would pay a monthly subscription.

4.3 DISCUSSION AND CONCLUSIONS

Results show that inhabitants aged 18-29 are high consumers of public transport and, whenever it is available, they would continue using this type of transport over the private car or alternative means. In general, sharing a ride is more attractive for the youngest than driving a car (owned or shared). By contrast, 30-45 and over 45-year-old inhabitants would always prefer to drive than sharing rides. However, the population aged over 45 showed a better predisposition in using ridesharing services than the residents aged 30-45.

Emerging mobility services were still very unfamiliar to the general public and this lack of knowledge affected the out coming intention of use, since data indicates that previously experienced users had a substantially superior usage intention in all the services analysed. The highest willingness identified from the youngest population and from Barcelona inhabitants –outside the city there was hardly any shared mobility service available– towards the use of shared mobility services was proven to be linked with the fact of higher familiarity with this type of services.

Findings suggest that shared mobility services should be integrated with each other and with public transport, since respondents only preferred these services when they could not choose the options of travelling by car or public transport. Additionally, more than a quarter of non-users of public transport indicated that public transportation was not an option for them because their area was not covered or was inefficiently covered. On the other hand, more than half of interviewees used daily more than one mode of transport to reach their destinations, and a quarter of them used both public and private transport, under the assumption that the combination of both types of transports was the best travel option in terms of cost and time.

Consequently, and in line with the MaaS concept, this research proves that the design of integrated shared mobility services as a complement to the existing public transportation could contribute to a better and more sustainable urban mobility. However, according to respondents, they would not accept a monthly subscription and would prefer to pay per use.

Given that this study was framed in the metropolitan region of Barcelona –including inhabitants of several localities with unequal degrees of availability of both public transport and shared mobility services, and also with different levels of quality of public transport service (i.e. service frequency, speed, and crowds)– and that the majority of those surveyed had never used a shared mobility service, the need to conduct another study with a user base having the same knowledge of the services to be analysed is detected.

Consequently, the next chapter provides a research focused on the needs and expectations of users of shared ride-hailing services, through the analysis of two case studies. We choose to focus on shared ride-hailing services since, on one hand, these are the least known services by participants of the study reported in the present section; secondly, the services offering shared rides are the ones which could contribute more to improve the mobility in our cities (Martínez et al., 2015; Alonso-Mora et al., 2017; Yu et al., 2017); and thirdly, as mentioned previously as a hypothesis, we assume that self-driving will make ridesharing identical to shared ride-hailing. Furthermore, both case studies provide key insights that enable us to understand and analyse the most suitable market opportunities for on-demand shared ride-hailing services, to recognise the target users, and to better understand their requirements for an adequate service design.

Chapter 5. MAPPING OF SERVICE DEPLOYMENT USE CASES AND USER REQUIREMENTS FOR ON-DEMAND SHARED RIDE-HAILING SERVICES

With the purpose of decongesting cities offering a similar comfort and convenience of the private car, and this way filling the gap between the cities' bus services and the regular taxi services, shared ride-hailing transportation is discreetly emerging in cities all over the world. The progress of technology and the arrival of smartphones have enabled the deployment of this modern Demand Responsive Transportation (DRT) in a variety of urban and suburban use cases, although they serve mainly high density areas without a concrete purpose.

According to IERMB (2018), European Commission (2011), Eriksson et al. (2008), and also confirmed in the case study presented in Chapter 4, the main reasons of car users to not use public transport are the lack of connections, its low frequency, the longer travel times, and that it is not as convenient, comfortable, and direct as the car. Hence, app-based on-demand shared transport services such as real-time ridesharing and shared ride-hailing could improve urban mobility since they seem to better fulfil the main requirements of car users in comparison to public transport, shortening waiting and travel times, and guaranteeing a seat (Enoch et al., 2004).

In this chapter, the analyses of two shared ride-hailing service test case studies are presented. The first case study took place during one week in Barcelona with the participation of 55 volunteers, who used the pilot shuttle service launched by CARNET[36] to commute from the city centre to the most western district of the city. The second case study was based on the service test of MOIA[37] in Hanover and involved the participation of 1,211 users.

The main goals of these two case studies are to provide the main findings about user requirements and market opportunities to contribute to the successful design of the new generation of DRT, to compare shared ride-hailing transportation with the bus and taxi services, and to investigate if shared ride-hailing services would be a suitable commuting transport mode from users' perspective, i.e. users prefer this type of transport instead of their private motorised vehicles.

Apart from simulation studies, the research done so far on ride-hailing was mainly focused on the business model of Peer-to-Peer (P2P) services but without considering their shared option, i.e. on-demand private trips cheaper than taxi trips, provided for instance by Uber (Bonazzi & Pigneur, 2015; Gao & Zhang, 2016; Watanabe et al., 2016; Watanabe et al., 2017), Uber's surge pricing model (Chen et al., 2015; Hall et al., 2015), and their workforce and regulation (Hall & Krueger, 2015; Rogers, 2015; Ross, 2015). Thus, the appropriate deployment of shared ride-hailing services to maximise the benefits of cities, users and operators, as well as the identification of the user requirements depending on the use cases, remains unstudied. As most of the research done so far comes from the traditional

[36] For more info, see: http://www.carnetbarcelona.com
[37] For more info, see: https://www.moia.io

DRT, a literature review covering several key topics related to it as a basis for the current research was conducted.

This chapter provides, first of all, an overview of the service design of DRT. Then, the CARNET pilot shuttle service and the MOIA test service case studies are presented, including the description of the methodology used to conduct the investigations as well as the analysis of their results and related discussions. Finally, the conclusions of both case studies are presented together.

5.1 Introduction to Demand Responsive Transportation

DRT is still an underutilised mobility solution, despite being a cost-effective solution for many use cases (Interreg Europe, 2018). Also known as flexible transport or paratransit services, it dates back to the late 1960s, when it was mainly used to provide a more economical public transport to suburban and rural areas (Rimmer et al., 1984). During the last ten years, this type of DRT has evolved from being a dial-a-ride service operated by public transport operators or taxi companies to app-based services operated by Transportation Network Company (TNCs).

According to Enoch et al. (2004), DRT was used for four concrete purposes: to feed public transport (Interchange DRT), to enhance public transport (Network DRT), to serve a particular destination (Destination-specific DRT), and to substitute public transport (Substitute DRT). Enoch et al. (2004) analysed 74 different purpose services, from 1969 to 2004, and categorised them as: public policy services, which covered low density areas in a more efficient way, such as the Phone and Go in Northumberland and the LinkUp in the county Tyne and Wear (Brake & Nelson, 2007; Nelson & Phonphitakchai, 2012); or commercially driven services, which covered strategic use cases such as the commuting or specific use cases like trips to and from the airport. In their work, Jain et al. (2017) focused not only on providing a transport service in underserved areas, but also to minority disadvantaged groups, such as elderly, young, and disabled people without access to a motor vehicle and with low incomes. Finally, a more modern service –the Kutsuplus pilot in Helsinki– was analysed by Weckström et al. (2018). Kutsuplus enabled a pre-booking with less anticipation, up to 30 minutes before the trip, which could be requested via the website or SMS instead of per-call.

The success factors identified to maximise the growth and opportunities of DRT are, according to Enoch et al. (2004) and Brake & Nelson (2007), the need of good partnerships, to identify and understand real user requirements, and effective marketing to potential users. Weckström et al. (2018) specified that marketing should be educational on the use of service and confirmed the importance of identifying the end user target group. In addition, Davison et al. (2012) highlighted the need of collaboration among all stakeholders, the redefinition of their current roles in DRT, and the technological advancements. Already in 2004, when it was not yet known that the arrival of the smartphone would revolutionise the market of the commercially driven DRT, Enoch et al. (2004) identified the progress of technology (i.e. advances in digital maps, GPS technologies, and Internet) as a key factor for the growth of such services. Apart from that, the authors noted the risk of failure due to not having a balanced flexibility and a realistic costing. Later, Davison et al. (2012) also highlighted the key role of technological advancements, specifically, in programming and software, availability of smartphones, and cloud computing. In particular, Hosny & Mumford (2009) and Basnal et al. (2015) categorised the efficient routing and grouping algorithm as a crucial part of the DRT. Furthermore, Weckström et al. (2018) suggested to improve the usability of DRT by the integration into the public transport fare system, in the direction of the MaaS concept. On the other hand, Enoch et al. (2004) also identified the following barriers: call centres operational costs, the lack of legislation, funding and political support, the absence of mobile telephone coverage in some rural areas, and the resistance to ride-sharing.

Highly valued design factors from users' perspective are, by Enoch et al. (2004), the certainty of arrival time, being a door-to-door service, the price, and the vehicle comfort. However, the importance of these factors was found to depend on the type of user and use case. For instance, users with access to a car higher valued a door-to-door service and the vehicle comfort, whereas users without access to it gave more importance to the price. Moreover, Enoch et al. (2004) recommended to not forget the factors required to increase the modal shift such as the good reliability, accessibility, frequency, cleanliness, vehicle heating and cooling, being easy to understand, and having friendly and helpful staff. Nelson & Phonphitakchai (2012) also stated that informing the fixed time of arrival and being door-to-door is important, mainly for the elderly and also during the night, and that negative experiences were related to the booking system or journey problems. Finally, Brake et al. (2004) added that the fare structure should be easy to understand, discussed that some service and vehicle characteristics might be compromised –such as the vehicle low floor design, which could be suitable for passengers but not for rural roads–, and suggested that the integration with all public transport services would help DRT to be more economically sustainable.

Concerning the user requirements, Weckström et al. (2018) found that a lower price than the taxi was the main reason for Kutsuplus riders to use this DRT, followed by the speed in comparison to public transport, due to the lack of good public transport connection, the ease of ordering a trip, and lastly, problems related to the use of the personal car such as the lack of parking spaces. On the other hand, users who stopped using Kutsuplus left the service due to the complexity of the booking and paying fare, the high cost, the long walking distance to the pick-up/drop-off point, and because they used other public transport means. In addition, Weckström et al. (2018) identified that the users did not like to prepay the trips and that they would have liked that the service covered the whole urban area of Helsinki, including the airport.

Regarding market opportunities, Enoch et al. (2004) identified that the most suitable use cases for using a DRT are shopping, health, and leisure trips. Nelson & Phonphitakchai (2012) stated that LinkUp was mainly used for leisure trips, and other uses were shopping, entertainment, friends, relative visits, health visits, and commuting. Social or recreational was as well the most common trip purpose of Kutsuplus, followed by commuting (work/school), business, and lastly, shopping (Weckström et al., 2018). The authors also stated that most of the rides were individual and were conducted in the afternoon and evening. Kutsuplus was also appreciated for being a safe evening/night transport and a safe transport for children to travel alone to their hobbies or school. Finally, Ryley et al. (2014) analysed six market niches for a DRT: rural hopper, shopping services, airport access, station access, employment shuttle, and hospital access. From a viability analysis point of view, they concluded that only the airport and station access DRT could be financially viable, linking their success to the destinations' parking cost and availability, important for the commuting and business use cases.

It is worth mentioning that new app-based shared ride-hailing services, although they usually cover high density zones such as city centres, in some occasions they provide as well a transport solution at a low investment to peripheral neighbourhoods with inefficient access to public transport, like the first dial-a-ride services. For instance, Morozov (2016) explained that some U.S. local administrations asked Uber –in exchange for significant subsidies– to assume public transport functions in areas where infrastructure was poor; Bliss (2018) reported partnerships of public transport authorities with different TNCs to supply Interchange DRT, Network DRT, Substitute DRT, and also DRT to non-emergency 911 calls; and Watanabe et al. (2017) remarked that, in countries like Saudi Arabia, Uber offered reliable transportation to women, thus enabling them to have jobs. Therefore, market niches could be either public policy or commercially driven, or a combination of both.

This review sheds light on design factors, user needs, and market opportunities for DRT deployment, which can be a base for the design of shared ride-hailing services. However, on-demand shared ride-hailing provides more use cases than traditional DRT, therefore, it is necessary to identify not only which use cases might have a higher usage rate, but also whether the design factors depend on the type of users and use cases.

5.2 Barcelona's Commuting Pilot Case Study

The first case study considered was a small-scale one-week commuting pilot launched by CARNET in Barcelona that took place from the 24th to the 28th April 2017. Previously, a selection of interested participants (67) was made according to the origin and destination of their commuting trips, since the service designed was a destination-specific DRT that connected the city centre of Barcelona (Eixample district) with the most western district of the city (Les Corts), as shown in Figure 20. Participants willing to participate had to fill out an online request form, the link of which was distributed to students and employees from Universitat Politècnica de Catalunya and employees from RACC[38]. Both organisations collaborated in this way in the study. The rides had no cost and could be requested from 7 to 10 a.m. and from 4 to 8 p.m. The vehicles used were 10 black SEAT Alhambra with a seating capacity of 4 people plus the driver. In addition to volunteers' requests, the system also received virtual requests based on a real demand pattern. Thus, the service attempted to resemble reality as close as possible, which implied, among other topics, that real users had to wait for the service as in a real situation as well as to understand the detours that the vehicle took to pick-up or drop-off other users, either virtual or real.

[38] For more info, see: https://www.racc.cat

Participants were asked to first download the application provided by Shotl[39] for the on-demand pick up requests; then, to use the service every day of the week; and after the pilot week, to answer an online survey, which was completed by 55 participants. To request a ride, users had to specify the trip origin and destination –within the covered areas– and the number of people travelling with them. Then, the app showed the pick-up time and location, the estimated time of arrival, and the drop-off site. At that point, users could either book the seats or reject the offer. Due to the service not being door-to-door, the pick-up and drop-off spots were between 100 and 400 metres far from the addresses specified by the users.

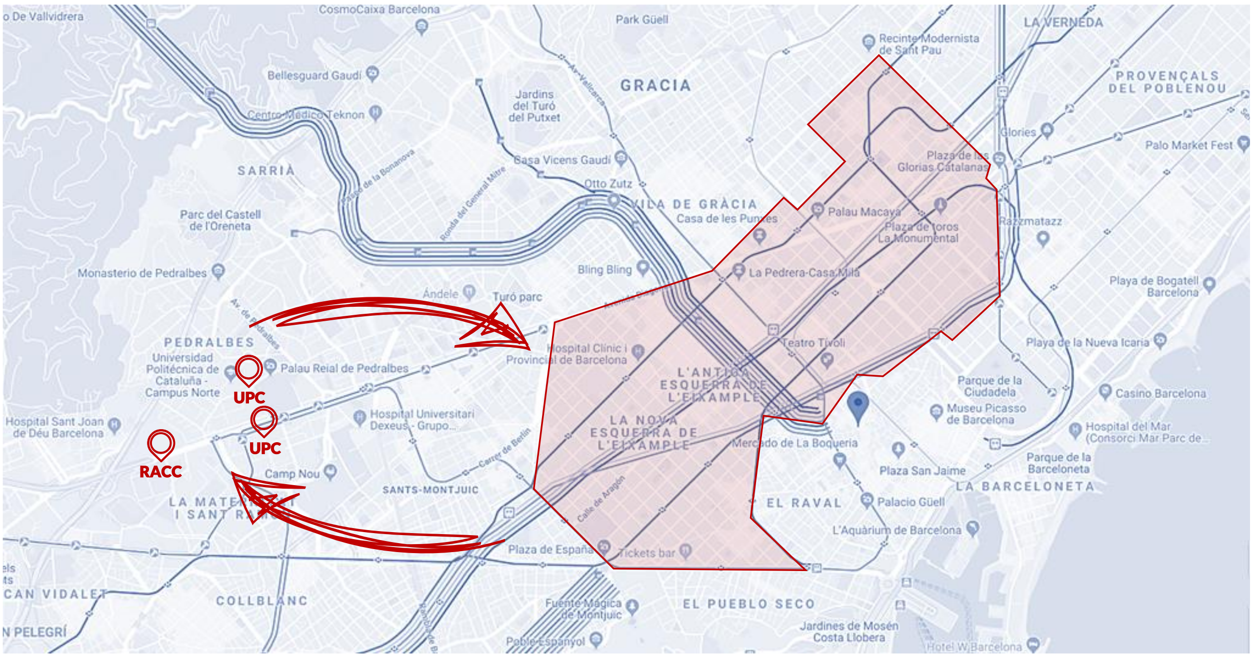


Figure 20. Service area of the CARNET pilot shuttle service.

5.2.1 Methodology

To compare the shared ride-hailing service with the bus and taxi services and to identify the most valued service factors from users' perspective, a survey to this pilot's users was conducted between the 2nd and the 18th May 2017. The questionnaire applied (see appendix B) was structured in 3 blocks, as shown in Figure 21. The first block asked the following demographic information and mobility patterns (classification questions): gender, age, employment status, if they had a driving license and a car or a scooter at their disposal, if they were intermodal commuters, and which means of transport did they usually use to commute. The second section aimed to find out, using a 7-point rating scale, first, users' perception of specific aspects of the service, based on their experience during the pilot phase, and second, their expectations and requirements as users facing a possible future introduction of the service. Thus, participants had to value the importance of eight service design factors: price of the service, distance to the pickup point, waiting time (notified when requesting the trip by the app), travel time, the fact of sharing the trip, comfort, and punctuality of the arrival of the vehicle at the

[39] For more info, see: https://shotl.com

pickup point and arriving at the destination. Also, participants compared the shared ride-hailing service tried with the bus and taxi services. Finally, in the third section it was requested to assess the importance of general service factors, select in which use cases they would use this type of transport (multiple choice question), and indicate how the price of the service should be calculated (closed-ended question).

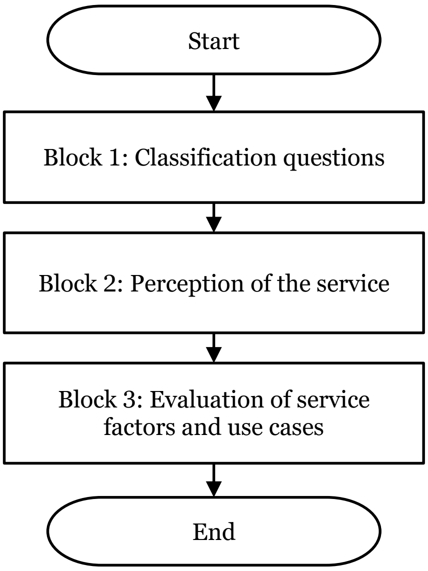


Figure 21. Structure of the questionnaire of the Barcelona case study.

5.2.2 Analysis of results

The result of the survey is explained hereafter. First, the profile of the participants is presented, followed by their intention to use shared ride-hailing services in a range of situations. The analysis of user requirements is then conducted by comparing the pilot service with the bus and taxi, and by evaluating several service factors.

Participants' profile and mobility patterns

The respondents profile is described in Table 9. Most of the participants were under the age of 45 (85.5%), were employed (72.7%), and had a driving license (85.5%) and access to a car (51%).

Table 9. Respondents' profile of Barcelona's pilot.

Question	Stated answers	No. of responses
Gender	Men Women	32 23
Age	18-29 30-45 +45	27 20 8
Driving license	Yes No	47 8
Car at disposal	Yes No	28 27
Motorcycle at disposal	Yes No	15 40
Occupation	Employed Student	40 15

Concerning participants' mobility patterns to commute, as shown in Figure 22, most of them commuted by public transport (67.3%) using mainly the underground and the bus, since the areas covered are easily reachable by these means. However, half of these users stated that they needed to use more than one mode of transport to reach their destinations. For details of the underground and train lines in the areas covered by the pilot, see Figure 20. In addition, Barcelona has an extensive bus network consisting on 97 lines (Grup TMB, 2019).

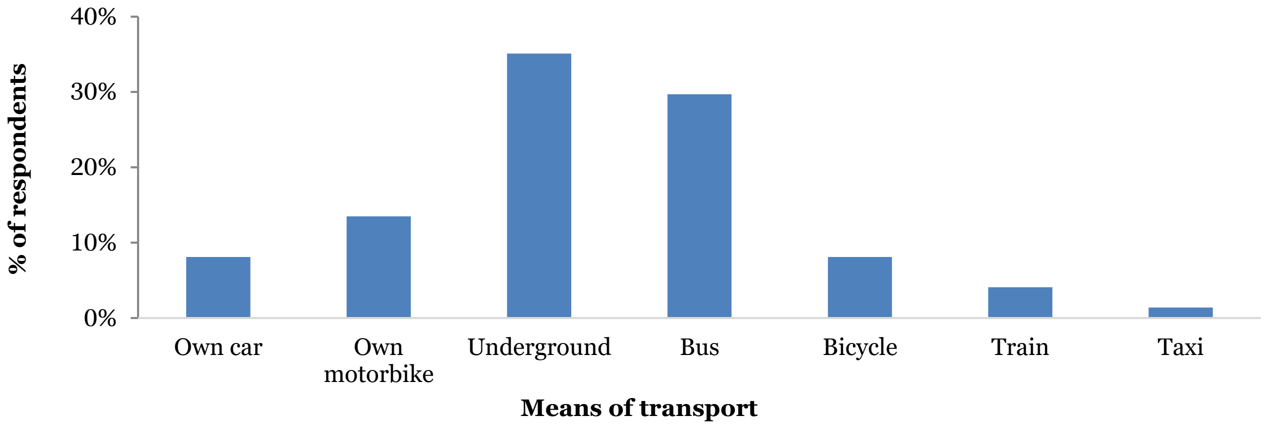


Figure 22. Participants' most usual commuting means of transport.

Use cases

The pilot service connected two areas of the city of Barcelona during the commuting hours; therefore, participants used the service, mainly, to commute to work or to the university. Accordingly, the most voted use case was "to commute" (70.9%). This would therefore confirm that this mobility service could be a suitable mode of transport for this type of trips. Also, 67.3% of participants would use it "for leisure trips", such as going to the gym, going out to dinner or to parties; 50.9% "for business trips"; and 47.3% to visit the doctor or go to the hospital ("to go to medical visits"). Shopping (either for groceries or not so regular purchases) and "for regular trips with family", such as picking-up children at school, reached a lower intention of use. Figure 23 shows participants' intention of use for each use case, in average and by age.

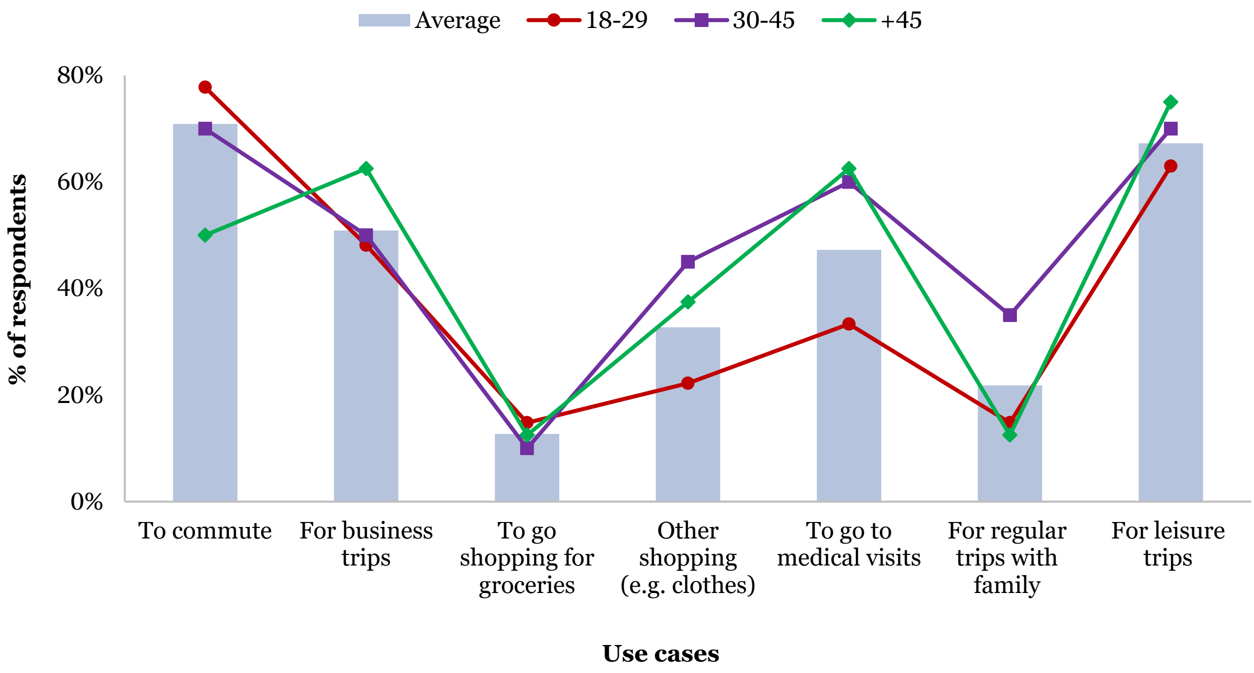


Figure 23. Intention of use of a shared ride-hailing service in different use cases, by age.

By age, as shown in Figure 23, the most noteworthy differences are found in the commuting use case, where participants over 45 years old show up to 28% less interest, and in the occasional uses of “other shopping” and “to go to medical visits”, where the 18-29 age group show up to 23 and 29% less interest, respectively. Between genders, women expressed a slightly higher intention of use in all cases, in particular in the cases of “to go to medical visits” (30% higher) and “to commute” (17% higher). On the other hand, there are no significant differences according to the availability of a driving licence, but depending on the availability of a car or a motorbike. Particularly, in the use cases “to commute” (participants without access to a car expressed an intention to use 21% higher) and “for business trips” (the usage intention of those who did not have a motorbike was 24% higher). And by occupation of participants, employed participants expressed a higher intention of use in all use cases compared to students, except “to commute”.

User requirements

Shared ride-hailing services are considered a mode of transport between the bus and taxi. Therefore, it is interesting to analyse relevant design factors and to detect how the users see the service in comparison with these other two means of transport. Accordingly, we analysed their opinion related to eight design factors: price of service, distance to pick-up points, waiting time, punctuality of the arrival of the vehicle at the pick-up point, travel time, the fact of sharing the trip, comfort, and punctuality arriving at the destination. Interviewees expressed their opinion on a scale of 1 to 7: being 1 the lowest rate *“Strongly disagree”* and 7 the highest: *“Totally agree”*.

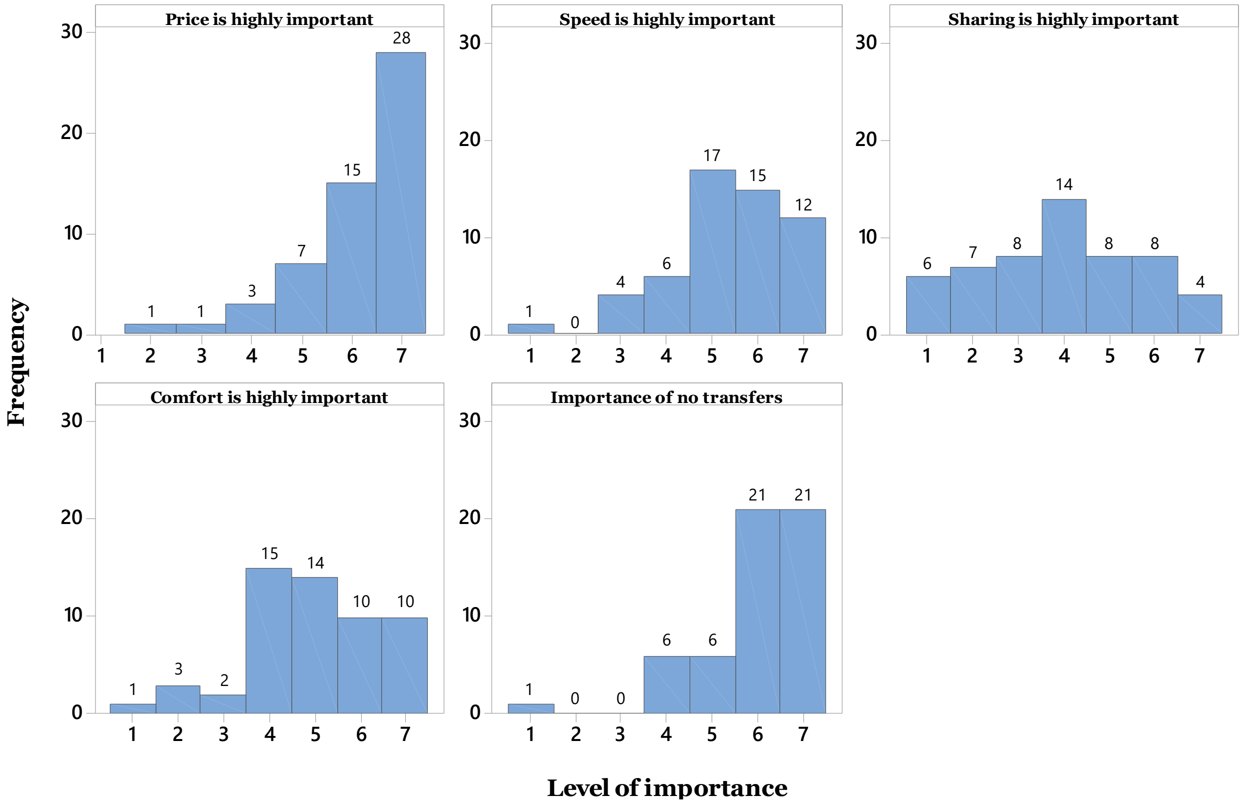
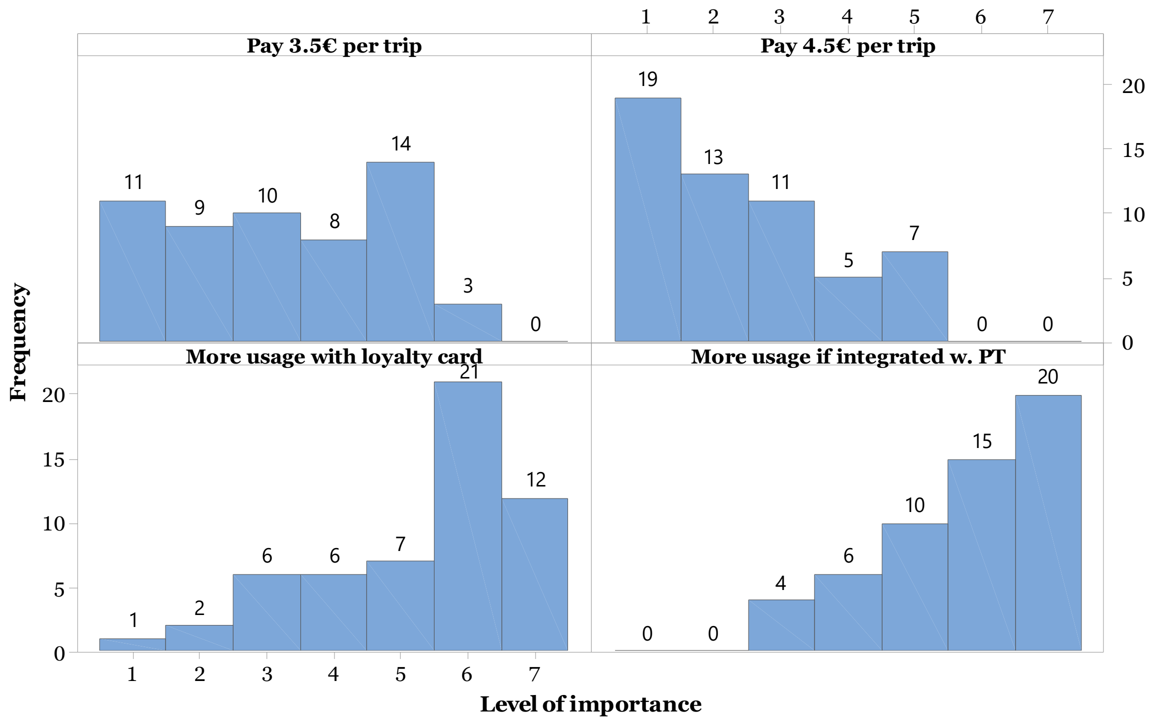


Figure 24. Histogram on the importance of the factors of price, speed, sharing, comfort, and no transfers.

According to the answers given, users valued the importance of the following factors: price, speed, sharing, vehicle comfort, and the convenience of not having to transfer, for becoming a regular user of a service such as the one tested. On the factors surveyed, we found that the most important one from users' perspective when it comes to turning into a regular user of a shared ride-hailing service was the price, followed by the convenience of not having to transfer, the speed, and the comfort of the vehicle (Figure 24). As illustrated in the histogram, participants noted indifference to the fact of sharing the trip with other users. By classification groups, no variations of this pattern are detected, except for the age group 30-45, who prioritised speed over price, and for motorbike users, who gave slightly more importance to not having to transfer than to price.

Concerning the price factor, participants did not agree on one option to establish the price. 38.9% would prefer having a flat rate to travel within the city, whereas 33.3% would prefer that the price was related to the distance of the straightest path, and the remaining 27.8% to the travel time on the fastest way. Figure 25 shows the frequency of answers related to price design aspects. It is worth noting that only 30.9% of participants would pay up to 3.5€ per trip (ratio of answers 5 to 7), whereas only 12.7% would agree on paying 4.5€. Although the willingness to pay even a higher price could be higher in other areas and for other use cases, such as travelling within suburban areas or for night uses. For the type of trips offered in this pilot –between 4 and 7 km long– a taxi would charge, on average, from 8€ to 12€. On the other hand, public transport would cost 2.20€ if travelling with a single ticket or 1.20€ if travelling with a multi-journal ticket. Therefore, this factor can be critical to design a successful service, and specially, if the areas covered had a good public transport service. In addition, 72.7% of participants specified that their use would be higher if they had a loyalty card and 81.8% would increase their use if the payment method could be the same as the public transport.



Note: PT=Public Transport

Figure 25. Histogram on the importance of price design aspects.

Related to the distance to pick-up points, 85.5% of participants would be willing to walk up to 5 minutes to the pick-up point, whereas only 27.3% would walk up to 10 minutes. On the other hand, 25.5% of participants would pay more than the fixed rate for a closer pick-up (Figure 26). As stated before, the pilot service picked up and dropped off users from 100 to 400 metres far from their origins and destinations. This distance was considered shorter compared to the regular bus by 54.5% of participants. In Barcelona, bus stops and underground stations are separated by a distance of 400 to 600 metres, approximately. Therefore, the distances considered in the pilot were adequate.

On the other hand, 51% of participants would not mind waiting up to 10 minutes for being picked up. But, 32.7% would pay more than the fixed rate for a shorter waiting time (Figure 26). By comparing the waiting time of the pilot service (time notified when requesting the service of the arrival of the vehicle) with the bus and taxi services, we saw that, although in the area covered by this pilot, the public transport service frequency was very high and, therefore, our participants were not used to wait more than 5-10 minutes, about 43.6% of participants considered that the waiting time of the pilot service was shorter compared to the usual waiting time of the bus, whereas 23.6% considered it shorter compared to the waiting time of the taxi service. This way, pilot results indicate that waiting up to 10 minutes for trips within the city would be accepted and higher waiting times might also be accepted for trips out of the city centre, where public transport is not so convenient.

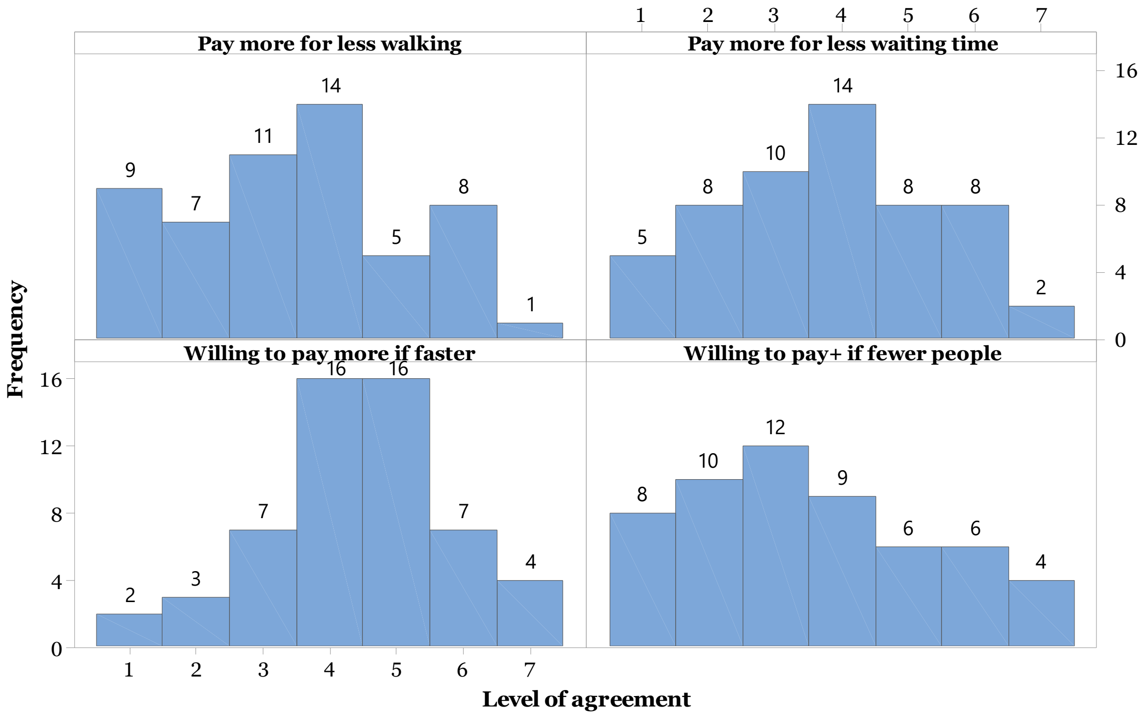


Figure 26. Histogram of situations where users would pay more for the service.

Moreover, 70.9% of users would accept a delay on the arrival of the vehicle if they would reach the destination on time, whereas 43.6% of users would accept up to 10 minute-delay involving arriving late at the destination. However, this percentage rises to 83.6% if users would receive an economic compensation (e.g. free trip). In this case, 40% of users considered that the pilot service was more punctual than the bus, whereas 34.5% agreed on that it was more punctual than the taxi. Although punctuality of the pilot service had room for improvement, the results indicate that non-recurrent short delays would be accepted.

Regarding the travel time, 47.3% of users would pay a higher price if the service was faster (Figure 26). Although the speed of the vehicles was similar to the average speed of the bus service in Barcelona, since these vehicles could not use the bus lanes, 65.5% of participants considered that, once inside the vehicle, the pilot service was faster compared to the regular bus. In contrast, only 16.4% of participants considered that it was faster than the taxi service. Due that this was a shared service, rides did not go direct to the destination and involved short detours and also short stops, to get other riders picked up and dropped off.

It is worth noting that sharing the ride to meet other users was not so important for the participants. This way, 29.1% of participants would pay a higher price if rides would be shared with less people (Figure 26). Thus, 74.5% of participants liked to share the rides with fewer people in comparison to the bus service.

The fact of not having to transfer is more important for users than the comfort of the vehicle used, 87.3% and 61.2% respectively. Though they appreciated the comfort provided by the vehicles used for the pilot. 89.1% of users rated the comfort of these vehicles better than that offered by the bus service and 54% rated it better than that offered by the taxi service.

Furthermore, 89.1% of users would not mind a delay of less than 5 minutes in arriving at the destination. However, only 47.3% of users would accept a delay of 5 to 10 minutes. But, if arriving with delay was compensated with the amount paid, 61.8% would accept a delay up to 10 minutes.

Finally, the importance of general characteristics related to the service and to the car design were analysed. We found out that the most important service characteristics from participants' point of view were reliability, availability, safety, and cleanliness of the vehicle. Notice that in Figure 27 these four factors have a high score and small deviation. On top of that, the integration of the service with other means of transport was also seen critical. Users would like to use the integrated transport ticket of public transport to also pay the trips of shared ride-hailing services. These types of tickets enable users to also be able to transfer between the different city transport services paying only once.

Other characteristics with less score but also considered important were privacy issues, the reputation of the service provider, and that the vehicle was electric (vehicles used were not electric). Instead, the brand of the vehicle, its design (aesthetic), and additional services such as the Wi-Fi or having magazines to read on board were not so important.

By classification groups, the following slight differences are detected: 1) the older the users, the more important the issues of privacy and vehicle electrification; 2) women valued safety and cleanliness more than men; 3) car users valued more than non-car users the possibility of having additional services; and 4) participants who did not have a motorbike valued the characteristic of being integrated with other services more than those who had a motorbike.

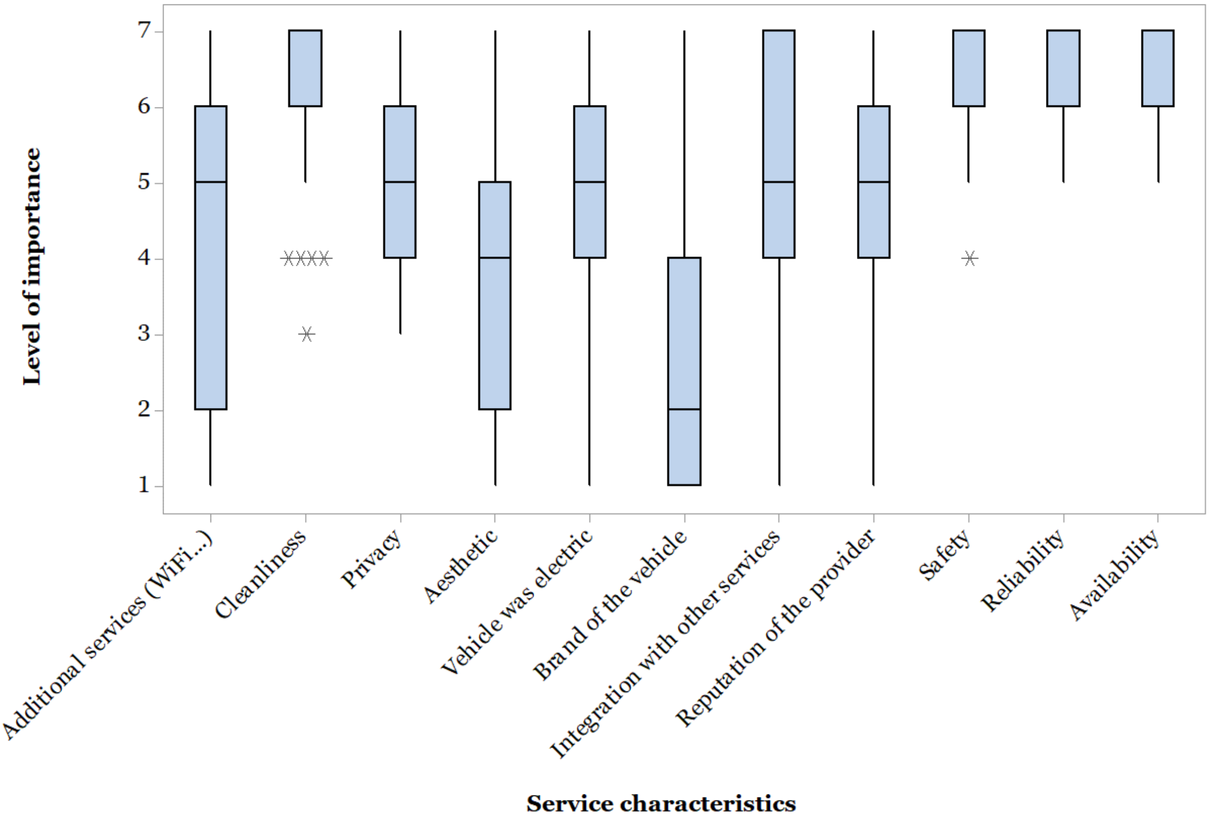


Figure 27. Boxplot of the importance of service factors to become a frequent user of the service.

5.2.3 Discussion

Shared ride-hailing services could be attractive transport alternatives for private car users (as they approach the quality offered by the private vehicles) and also for cities, since they would help relieve congestion if private car users became customers of this type of services. But this mode of transport is quite new, therefore, the need for identifying the main service design factors that would make this means convenient for both users and cities is necessary. This way, from the pilot conducted in Barcelona we detected the importance of setting a good pricing. Users would not pay more than the double of the price of the bus or the underground for a daily commute within the city. But the low price they would be willing to pay could complicate the profitability of the service. Therefore, other use cases were identified, for which these customers might be willing to pay more, such as leisure or business trips.

On the other hand, shared ride-hailing services could cover the gap between the bus and taxi services, thus offering shared trips like the bus, but with the convenience and comfort of the taxi. From the comparison of the service piloted with these two other means of transport, we identified that a shared ride-hailing service should offer shorter waiting times and a better punctuality in comparison to public transport, although for achieving that in city centres, it might imply having a big vehicle fleet and optimised algorithms.

This case study suggests that shared ride-hailing services should target different customer segments to be as cost-effective as possible. Specially, intermodal users and inhabitants travelling from, within, or to remoter areas. Concerning the value proposition, the application should offer an accurate estimation of the waiting and travel times as well as the ETA at destination. Apart from that, the service should guarantee availability at all times and be reliable and safe. Regarding the vehicles used to provide the service, users' main concern was that they were clean. Furthermore, partnerships with transport authorities and operators are considered key to achieve integrations within the fare systems as well as subsidies to cover interurban and remote areas in a more efficient way than the regular scheduled buses or even night services.

Finally, note that an attempt has been made to study the influence of the classification variables in the different analyses presented in this case study, and although some differences have been detected, it has not been possible to go into the detail due to the lack of a broader base of participants. Another limitation of this case study was that the service area and operation times of the pilot were quite restrictive. For this reason, another case study is designed and conducted (presented in section 0) with the aim of confirming the preliminary results obtained in this study, involving a broader user base of a less limited shared ride-hailing service, both in the service area and operating hours.

5.3 MOIA TEST SERVICE CASE STUDY

The second case study analysed was a broader shared ride-hailing service test provided by MOIA in Hanover, covering an area of 90 square kilometres (Figure 28). Hanover has a population of 535,603 inhabitants, which together with its area of influence –the 21 surrounding municipalities– totals almost 1.2 million (Region Hannover, 2018). The city receives a daily number of work-commuters equivalent to 32.8% of its population, the large majority of work-commuters living in the city remain in the city (70.3%), and 29.7% work outside the city (Elmer et al., 2018).

Inhabitants of Hanover region make almost half of all everyday journeys on foot, by bicycle, or by public transport (Region Hannover, 2018). In the city of Hanover, 20% of the population travels by bicycle and another 20% by public transport, whereas in the surrounding area, both the use of the bicycle and public transport drops to 10% (Region Hannover, 2018). The public transport network of the city consists of light rail vehicles (Stadtbahn) that cover different parts of the city, S-Bahn and regional trains to connect with the surrounding areas, and metropolitan and regional buses to complement the local rail transport. Furthermore, alternative means such as B2C and P2P carsharing and ridesharing are also available.

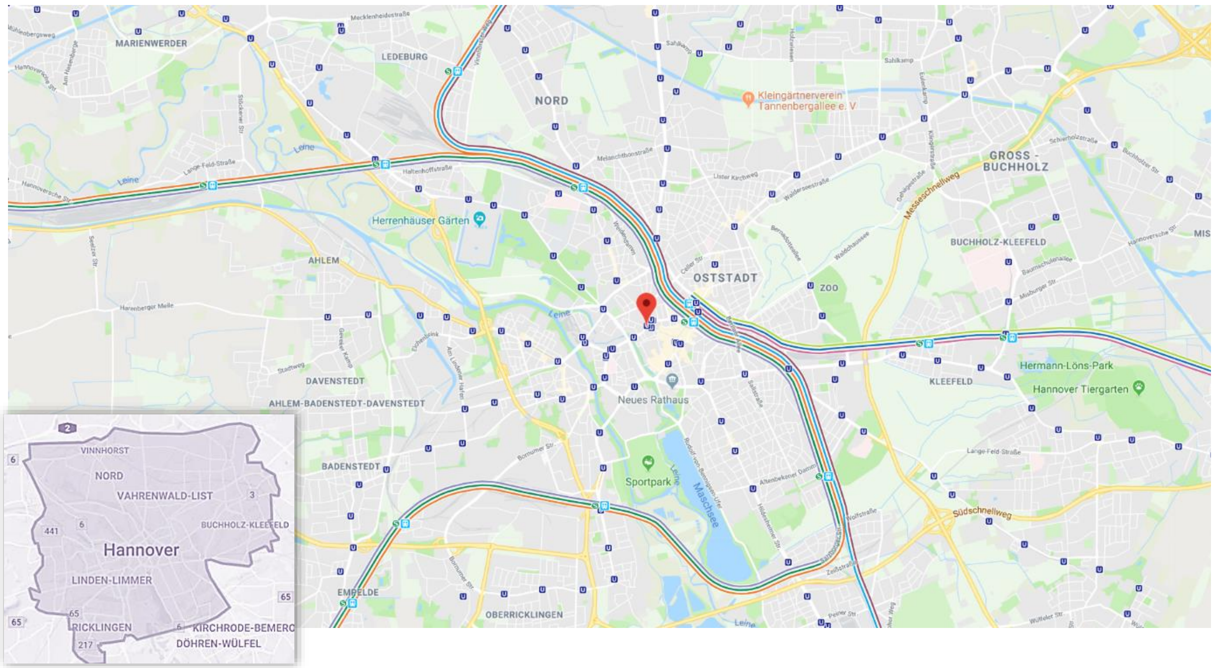


Figure 28. Service area of the MOIA test service.

MOIA service test started the 4th October 2017 and ended the 28th July 2018, after 300 days of testing and recording a total of 230,000 rides. Due to the German regulatory framework for non-commercial services, the price was limited to 0.06 euro/km per person. The service was provided on-demand, therefore users could not pre-book their trips in advance, and corner-to-corner, which means that the pick-up and drop-off spots were up to 250 metres far from the addresses specified by the users. The test was offered to 3,906 testers who previously expressed their interest to become testers through the service website. The vehicle fleet grew from 20 to 35 dark-blue Volkswagen T6 vans with a seating capacity of 5 people plus the driver. The operating hours were from Monday to Thursday 05:00-24:00, Friday 05:00-03:00, and Saturday 10:00-03:00.

In comparison to Barcelona's pilot, in this case, users were required to previously download the MOIA application –through an invitation–, open it, and fill in some personal information as well as the payment details. The process of requesting a ride was very similar to that of the Barcelona's pilot. The only differences were that, in this instance, there was one big service area and rides could be requested in any direction, the app showed a time window for the ETA instead of a fixed time, and the app also showed the cost of the trip. Regarding the pick-up and drop-off spots, they were set at a maximum distance of 250 metres. Furthermore, in this pilot, users could follow the progress of their trips through the app and monitor on the in-vehicle display the intermediate stops that would be made so that other passengers could be picked-up and dropped-off.

5.3.1 Methodology

To have a broad understanding of the user requirements and use cases for on-demand shared ride-hailing services, the service test of MOIA was analysed through an online survey participated by 1,211 registered users. This quantitative study was conducted between the 28th June and the 16th July 2018, applying a structured on-line survey with mainly closed-ended questions (see appendix C). The questionnaire was structured in 5 blocks, as shown in Figure 29: 1) classification questions, 2) commuting (i.e. trips to and from work or university), 3) personal mobility (i.e. all trips except business and commuting) and intention of use of shared mobility services for personal and occupational mobility, 4) experience with MOIA, and 5) reasons to not use MOIA.

The first block of the survey asked the gender, age, and location of participants, as well as if they had a driving license, and a car or a scooter at their disposal. The second block focused on the commuting trips, and participants were asked about their commuting destination (Hanover, surroundings of Hanover, or outside this area), the one-way trip length, and the means of transport used (multiple choice question). Non-commuters were excluded from block 2 and were directed to block 3. All questions from the third block were multiple choice and asked, on one hand, the means of transport used for individual private trips and private trips with family or friends; and on the other hand, the intention of use, in different use cases, of the following shared mobility services: MOIA, singular ride-hailing, P2P ridesharing, and carsharing. All these services were explained in detail and with examples, however, respondents had experience using MOIA and only a few using the other services. Finally, the aim of the fourth block was to find out if user requirements change depending on the type of trip (multiple choice questions). Thus, two scenarios were considered: a "work-study scenario" and a "social scenario". Since the survey was sent to all registered testers and it was important that block four was only answered by participants who at least had used the service once, a decision question was applied at the end of the third block. Participants excluded from the fourth block were directed to the fifth block, in which they were asked the reasons for not trying MOIA with an open-ended question.

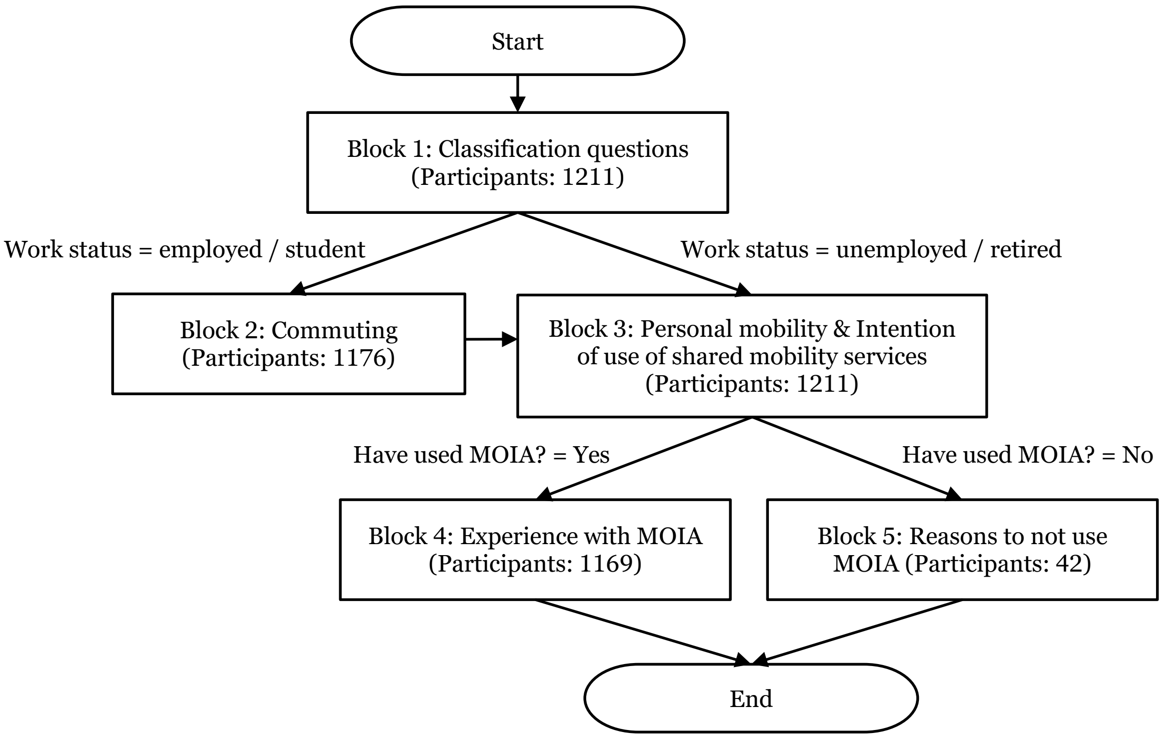


Figure 29. Structure of the survey of the Hanover case study.

5.3.2 Analysis of results

The result of the survey is analysed hereafter. First, the participants' profile and their mobility patterns are explained. Then, the participants' usage intention of shared ride-hailing services in a range of situations is studied. Finally, an analysis of the most important service requirements is conducted, from users' perspective, in two different scenarios.

Participants' profile and mobility patterns

The respondents profile is described in Table 10. Most of the participants were men, aged between 30 and 45, employed, and living in Hanover, which coincided with the profile of the total number of test users. 96% of respondents had a driving license, and 75.1% had access to a car and 13.7% to a motorcycle, owned or from a family member.

Table 10. Respondents' profile of Hanover's pilot.

Question	Stated answers	No. of responses
Gender	Men	817
	Women	394
Age	18-29	349
	30-45	526
	46-65	319
	+65	17
Driving license	Yes	1163
	No	48
Car at disposal	Yes	910
	No	301
Motorcycle at disposal	Yes	166
	No	1045
Place of residence	City	1088
	Surroundings	74
	Region or farer	49
Occupation	Employed	930
	Self-employed	99
	Students	147
	Unemployed	18
	Retired	17

The majority of MOIA users were using the service on all days of the week (76.8%), 15.5% used it only on weekdays, and the remaining 7.7% only at weekends. Regarding the frequency of usage, 44.7% used it more than once per week (out of which, 12.5% used it on a daily basis or almost daily), 44.9% from 1 to 4 times per month, and the rest 10.4% rode with MOIA less than once per month. To identify which variables were significant, a Pearson chi-square analysis at 95% confidence level (*p-value*<0.05) was conducted. The analysis revealed that there was a significant association between most of the classification variables (*gender*, *age*, *driving license*, *car at disposal*, *place of residence*, and *work status*) and MOIA usage (see Table 11, *p-value*<0.05 marked with *). Regarding these significant variables, from the statistics of use we observe that participants using the service more frequently were men, the 18 to 29-year-old segment, participants without driving license, participants without access to a car, those living in Hanover, and students.

Table 11. Pearson Chi-square test for association of MOIA usage frequency with classification variables.

Classification variables	*p-value*
Gender	0.004*
Age	0.002*
Driving license	0.000*
Car at disposal	0.000*
Motorcycle at disposal	0.086
Place of residence	0.000*
Work status	0.000*

** Significant variables*

Participants' use of different means of transport for "commuting", "individual private trips" and "private trips with family or friends" is shown in Figure 30. This comparison indicates that for personal mobility (private trips alone or with family or friends) participants used more MOIA and public transport and were also more multimodal (not always taking the same means of transport to get to the destination) than for commuting. For instance, some interviewees commented that they commuted by bicycle except when the weather was bad, then they used MOIA, or that they used MOIA as a feeder service to underground or train stations to then take suburban trains/undergrounds for further part of the journey. The use case with a higher usage rate of MOIA was "individual private trips", which was also the case in which both public transport and bicycles were used more, and the one with the lowest car use. That could be related to the fact that the cost of travelling by car alone within the city is expensive and sometimes also slow due to the traffic and the time required for finding a parking spot. In the case "private trips with family or friends", the use rate of MOIA was very similar to both the use rate of public transport and the private car. This means that the private car was sometimes more convenient than public transport when the rides were shared with the family –e.g. travelling with children with their prams– or with friends, then the costs of travelling by car were not so high since they could be shared. Therefore, shared ride-hailing services adapted to the needs of this type of users have the chance to substitute some of these private car trips. In reference to the use case "commuting", the main means of transport used by participants were the private car, followed by public transport, the bicycle, and MOIA. The highest use of the car was to commute within the surroundings, from the region or a further location to the surroundings, and from the surroundings to Hanover (81.2%, 80.6% and 78.2% respectively). In these situations, the use of the car surpassed by 40% the use of public transport, since in most cases, these trips did not have a direct public transport connection, were too long to be covered by bike, and were out of MOIA's coverage area. Hence, shared ride-hailing services covering this type of trips could have a high impact on reducing private car trips, without affecting other sustainable transport modes.

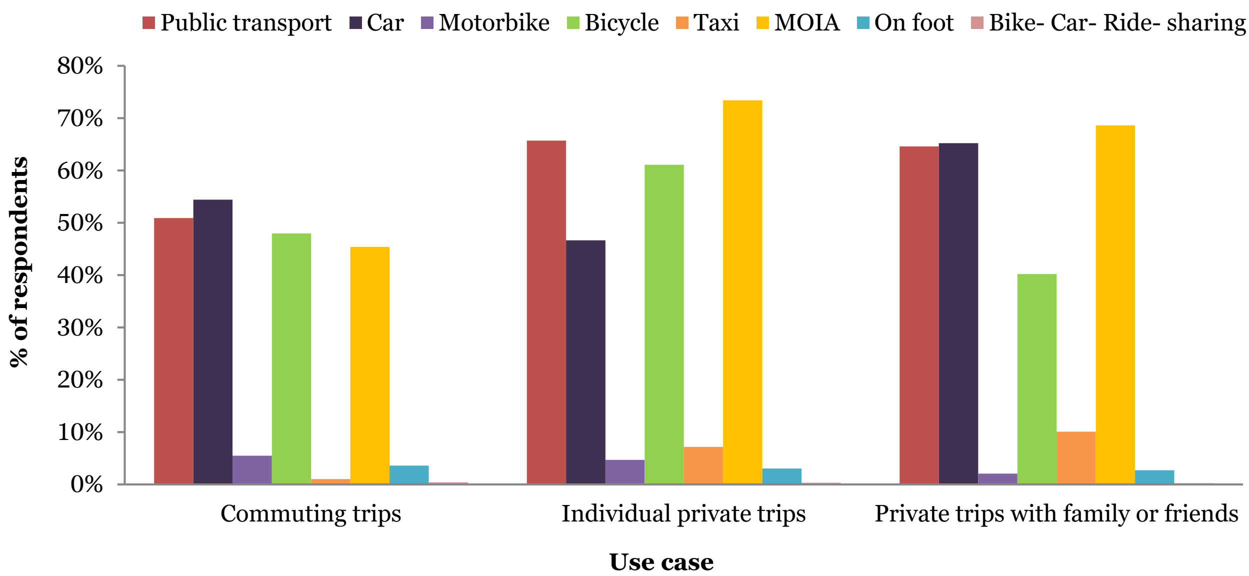


Figure 30. Means of transport used to commute (total commuters: 1165), travel within the city for personal reasons alone, or with family and friends (total participants: 1211).

Focusing on the use of MOIA, a statistical analysis was done to identify significant associations between the classification variables and the MOIA real use. Significant variables at 95% confidence level are, in all three use cases, the *age*, having a *driving license*, and the *place of residence* (see Table 12).

Table 12. Pearson Chi-square test for association of MOIA real use with classification variables.

Classification variables	**Commuting** ***p-value***	**Individual private trips** ***p-value***	**Private trips with family or friends** ***p-value***
Gender	0.186	0.348	0.254
Age	0.003*	0.000*	0.000*
Driving license	0.000*	0.010*	0.011*
Car at disposal	0.006*	0.131	0.101
Motorcycle at disposal	0.099	0.062	0.154
Place of residence	0.000*	0.001*	0.000*
Work status	0.007*	0.274	0.036*

** Significant variables*

In these situations, the segments with a declared higher use were: the 18 to 29-year-old group (up to 26% more than the oldest group, since the use gradually decreased as the age increased), participants without the driving license (29% more for "commuting" and 17% more for "private trips" compared to participants having the driving license), and participants living in Hanover due to the service only being available in Hanover (the most notable difference being in the use cases of "commuting" and "private trips with family or friends"). Additionally, for the "commuting", participants without access to a car used more MOIA than participants with access to it, and students also declared a higher use of the service for this use case as well as for "private trips with family or friends". Therefore, it is found that younger inhabitants were more opened to use this type of service. Among them, those being students, without a driving license, or without access to a car.

Use cases

Since the test service was also limited both in the service area and service hours, to better understand in which situations users would use a shared ride-hailing service, MOIA test users were asked about their usage intention of the service according to 9 different use cases. In addition, they were also required to state their usage intention, for the given cases, of other new mobility services: P2P ridesharing, carsharing, and singular ride-hailing. As shown in Figure 31, the intention to use MOIA was the highest for 7 of the 9 use cases. Only "for day trips" and "business trips" participants would prefer taking a carsharing, or also a singular ride-hailing service in the case of "business trips". The use cases with the highest intended use of MOIA came from: "to come home alone after going out" (93.4%), "to go out with family/friends" (81.9%), "to get to or from the airport" (78%), "to commute" (66.3%), and "to go shopping alone" (49.4%). Participants also proposed concrete use cases, such as trips to and from the train station, visits to doctors, and to go to certain events (concerts, festivals, etc.), as well as general uses such as trips to the city centre and outside the city. Compared to the use cases found in the literature review, these results confirm that shared ride-hailing is a suitable means of transport for leisure trips and also to potentially act as a feeder service to mass transport.

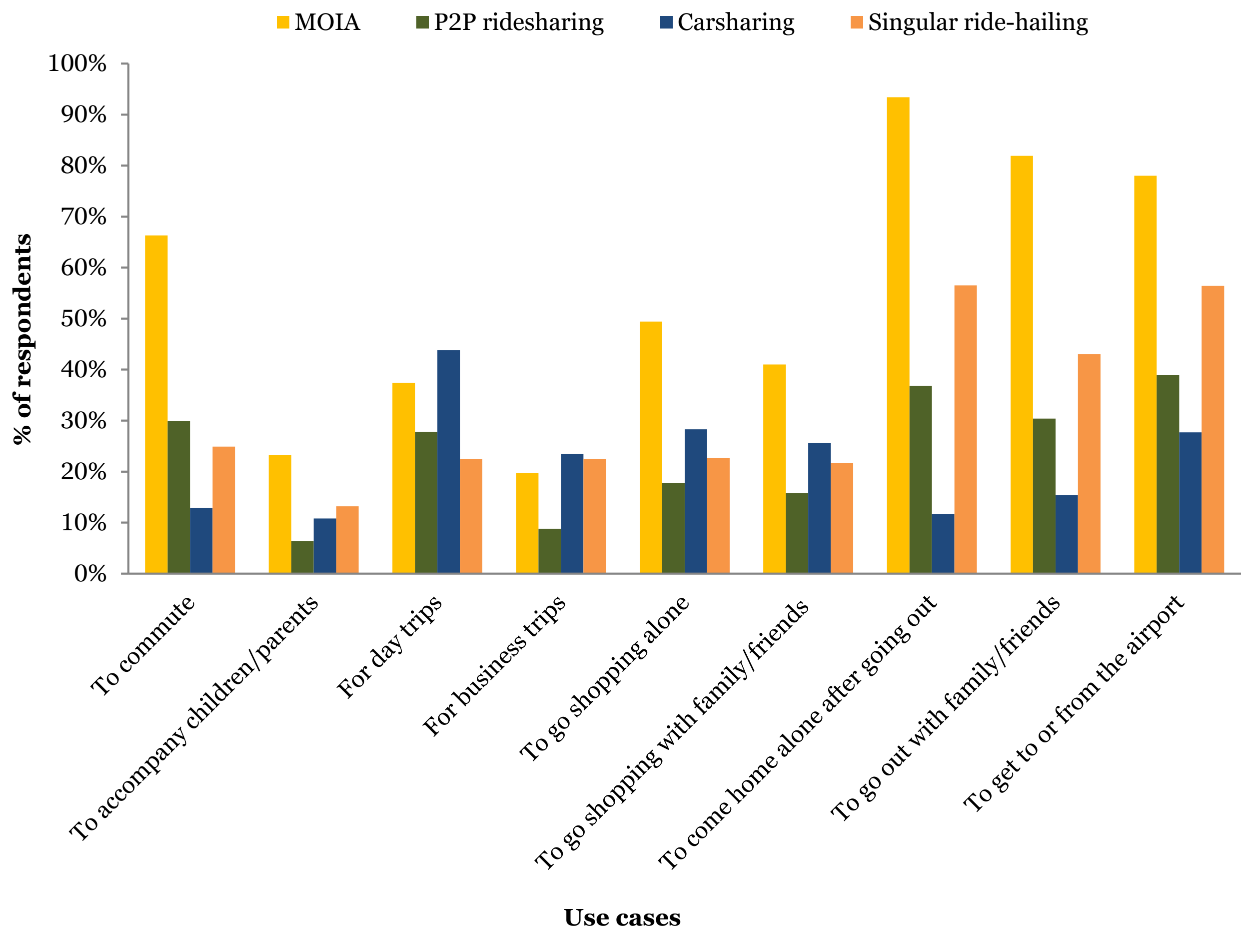


Figure 31. Intention of use of MOIA in comparison to P2P ridesharing, carsharing, and singular ride-hailing.

With the aim of finding out the target users of the use cases with a usage intention of MOIA similar or higher than 50%, we conducted the Pearson chi-square analysis shown in Table 13. In this analysis, the variable *usage frequency* related to the participants' real use of MOIA (more than one use per week, less than one use per week, never used) was also considered. Firstly, for the case "to come home alone after going out", the variables *age* and *work status* are relevant: participants older than 65 years –and retired– declared up to 23% lower intention of use in comparison to the other age and work status groups. Secondly, for the case "to go out with family and friends", the significant variables are *age* and *usage frequency*: the oldest segment declared again a lower usage intention (16% lower than the 18-29-year-old group and 10% lower than the groups 30-45 and 46-65), and regarding the *usage frequency*, non-users of MOIA expressed 18% lower intention of use than the MOIA users. In Chapter 4 it was already found that inhabitants without a previous use of this type of services were more reluctant to use them. Moreover, "to get to or from the airport" was also a more interesting use case for the citizens up to the age of 65, neither retired nor unemployed, and even a little more attractive for participants with access to a car. The greatest usage intention "to commute" was given by participants who did not have a driving license, residents of the vicinity of Hanover –where the MOIA service was not available–, and the already frequent users of MOIA. And the highest interest in "to go shopping alone" was expressed by women (11% higher than men), participants without access to a car, and frequent MOIA users.

Table 13. Pearson Chi-square test for association of the situations with the highest usage intention of MOIA.

Variables	**To come home alone after going out**	**To go out with family/friends**	**To get to or from the airport**	**To commute**$^{\alpha}$	**To go shopping alone**
	p-value	***p-value***	***p-value***	***p-value***	***p-value***
Gender	0.214	0.140	0.471	0.424	0.000*
Age	0.001*	0.027*	0.000*	0.225	0.292
Driving license	0.198	0.903	0.391	0.014*	0.119
Car at disposal	0.440	0.657	0.029*	0.612	0.021*
Motorcycle at disposal	0.676	0.130	0.904	0.442	0.406
Place of residence	0.139	0.793	0.353	0.031*	0.646
Work status	0.001*	0.300	0.015*	0.772	0.177
Usage frequency	0.577	0.006*	0.125	0.000*	0.001*

* *Significant variables*

$^{\alpha}$ Test conducted with the commuter user base (1165 participants)

The survey analysis revealed, on one hand, that the most suitable scenarios for an on-demand shared ride-hailing service from the users' point of view were: 1) leisure and shopping activities, specially for individual travellers; 2) direct connection to the airport; and 3) commuting as a complement to public transport, reaching areas that are not efficiently covered by this mode, or as a feeder of it. With regard to the commuting use case, it is noteworthy that when only considering those participants who had already used the MOIA service to commute (529), 87.3% of them validated this use case, indicating the highest intention (91.9%) all those who commuted between 5 and 10 km.

These three uses would be compatible with each other, since commuting takes place in peak hours, whereas leisure and shopping activities go on mainly during off-peak hours, and transfers to the airport run all day. The combination of these services would ensure a minimum occupancy rate of the car during the day and maximise the profitability of the service.

User requirements

In this section, the most important service requirements from users' perspective are analysed. In particular, the requirements are compared in two different scenarios: "work-study scenario" (i.e. commuting and business trips) and "social scenario" (i.e. travelling with family and friends). Since the aim of this part of the questionnaire was to find out the user requirements of a shared ride-hailing service based on the experience of the users of such a service, the respondents without this experience were excluded from this part. Consequently, the total number of participants for this part was reduced to 1,169.

Although the survey participants were registered as MOIA test users, 3.5% of respondents had not used the service before answering this survey. The main reason for not having tried it was due to their origin or destination being outside the area.

Participants were asked to value, on a scale of 1 to 5, 16 hypothetical improvements that would make them use the service more often for work-study related trips and for travelling with family and friends.

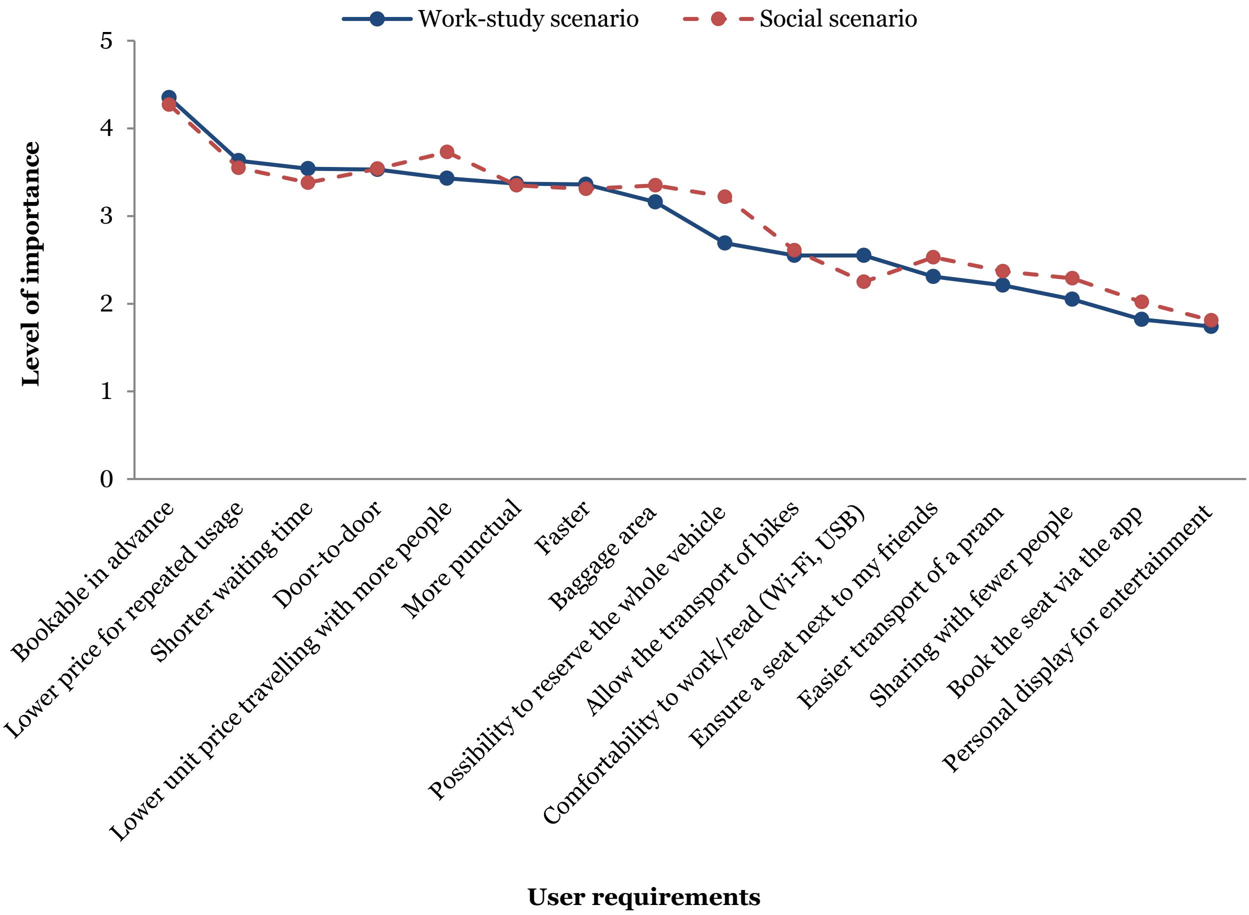


Figure 32. Answers to the question "I would use MOIA more often if..." in a "work-study scenario" vs. "social scenario".

From the results presented in Figure 32, which are sorted by the level of importance, one can observe that in both situations users wanted optimised waiting and travel times, and a competitive price for repeated usage and for travelling with more people. Also, they needed to feel safe and secure during the whole customer journey, i.e. from the booking to reaching the final destination. Less voted were the topics corresponding to comfort elements. Among them, the most valued were to have a baggage area –mainly related to the shopping and going to the airport use cases–, the possibility to reserve the whole vehicle –suitable for travelling with family and friends, since by not sharing with other users detours would be avoided and talks could be held without disturbing anybody–, to enable the carriage of bicycles on board –suitable for users wanting to pedal the first and last mile of their trips–, to offer Wi-Fi and USB chargers –slightly more important for the commuting use case–, and to ensure that the seats of the companions are together –suitable for trips with more people, specially in the case of families travelling with children–. The remaining topics had a level of importance of less than 2.5 points for both use cases. The reasons behind not giving so much importance to these topics were, in the case of the easier transportation of a pram, that it was not a general need; sharing the vehicle with less people was not the purpose of this business model, and users understood it; and reserving a seat via the app and having a personal display for entertainment were not seen as requirements since trips were relatively short. Participants proposed other improvements related to the service expansion, the accuracy and usability of the app, the navigation (more efficient and less derouting), and better calculation of the pick-up and drop-off times.

The comparison between the two scenarios shows that the importance given to the requirements is quite similar. Given these results, it should be noted that the key design factors for a shared ride-hailing service are:

- The reliability and availability: users asked for pre-booking to be sure that they would receive a ride at the desired time.
- The price, which should be competitive in the focused use cases –despite the low cost of the service test, the two improvements regarding the price calculation were highly voted–.
- The waiting and travel times: users do not want to wait and want to reach their destination quickly and on time.
- Short walking distance to the pick-up point and from the drop-off point to the final destination: users highly valued a door-to-door service to save the time of walking; for a better comfort in case, for example, of bad weather or travelling with baggage; and for safety, mainly in the case of night trips.

By means of the Pearson chi-square test, we analysed the significant associations between the demographic and behavioural variables and the most valued user requirements for both scenarios. Before, to have enough answers in each group, we converted the responses from the 5-point scale to a 3-point scale: not agree (1-2), not sure (3), agree (4-5).

First, the analysis of the requirements related to the "work-study scenario" with the commuter user base is presented (1126 participants, since those without experience riding with MOIA were excluded). In this analysis (Table 14), we also considered the variables associated to *MOIA user to commute* (yes, no), *car user to commute* (yes, no), and *Public Transport (PT) to commute* (yes, no) to explore if users of each of these means of transport had different requirements.

Table 14. Pearson Chi-square test for association of the most valued requirements in a "work-study scenario".

Variables	**Bookable in advance**	**Lower price for repeated usage**	**Shorter waiting time**	**Door-to-door**	**Lower price - trips with more people**	**More punctual**	**Faster**
	p-value	***p-value***	***p-value***	***p-value***	***p-value***	***p-value***	***p-value***
Gender	0.381	0.595	0.731	0.128	0.870	0.630	0.647
Age	0.073	0.000*	0.000*	0.243	0.019*	0.000*	0.000*
Driving license	0.813	0.867	0.842	0.981	0.533	0.891	0.723
Car at disposal	0.439	0.593	0.066	0.182	0.595	0.193	0.550
Motorcycle at disposal	0.437	0.279	0.039*	0.190	0.860	0.121	0.041*
Place of residence	0.847	0.831	0.742	0.000*	0.981	0.735	0.739
Work status	0.749	0.096	0.019*	0.393	0.070	0.007*	0.591
MOIA usage frequency	0.614	0.000*	0.036*	0.287	0.003*	0.000*	0.079
MOIA user to commute	0.524	0.001*	0.496	0.088	0.012*	0.004*	0.219
Car user to commute	0.568	0.850	0.162	0.013*	0.720	0.662	0.984
PT user to commute	0.933	0.076	0.076	0.285	0.244	0.015*	0.082

** Significant variables*

In this scenario, the variables *place of residence* and *car user to commute* are significant for the door-to-door service. Car users stated 8% more interest than non-car users –possibly as they are accustomed to car trips being door-to-door– and residents around Hanover stated 26% more interest than residents of the city, and 18% more interest than participants from the region or further. In relation to the *work status*, students gave approximately 15% more importance to time-related requirements than participants who were employed or self-employed.

Next, the analysis of the requirements related to the "social scenario" is presented in Table 15. In this case, to also find out if users of different modes of transport have distinct demands, we considered the variables *MOIA user for trips with more people* (yes, no), *car user for trips with more people* (yes, no), *PT user for trips with more people* (yes, no).

Table 15. Pearson Chi-square test for association of the most valued requirements in a "social scenario".

Variables	**Bookable in advance** *p-value*	**Lower price if repeated use** *p-value*	**Shorter waiting time** *p-value*	**Door-to-door** *p-value*	**Lower price - trips with more people** *p-value*	**More punctuality** *p-value*	**Faster** *p-value*
Gender	0.217	0.888	0.418	0.051	0.793	0.321	0.459
Age	0.020*	0.000*	0.000*	0.441	0.000*	0.000*	0.000*
Driving license	0.959	0.722	0.166	0.614	0.238	0.120	0.618
Car at disposal	0.665	0.951	0.616	0.188	0.910	0.099	0.978
Motorcycle at disposal	0.668	0.845	0.754	0.572	0.918	0.185	0.517
Place of residence	0.973	0.878	0.392	0.000	0.934	0.777	0.589
Work status	0.515	0.204	0.012*	0.846	0.013*	0.040*	0.118
MOIA usage frequency	0.267	0.001*	0.068	0.614	0.005*	0.022*	0.013*
MOIA user for trips with more people	0.041*	0.203	0.001*	0.011*	0.972	0.159	0.104
Car user for trips with more people	0.232	0.134	0.036*	0.388	0.734	0.663	0.887
PT user for trips with more people	0.859	0.145	0.111	0.462	0.141	0.189	0.786

** Significant variables*

In the "social scenario", retired participants stated about 30% less interest of time-related requirements compared to the other work situations. However, these results would be influenced by the age factor, since students were the youngest participants, and in general, the 18-29-year-old segment was the most demanding; and retired participants were older than 65, the least demanding age group. In addition, the variable of *MOIA user for trips with more people* is significant for the requirements of pre-booking, shorter waiting time, and door-to-door service –being the users more interested in the pre-booking and having a shorter waiting time, and less interested in a door-to-door service–.

By comparing both tables, we found that the *gender, driving license*, and *car at disposal* are not significant variables in any of the scenarios. Conversely, the variable *age* is significant in most of the requirements in both scenarios, and in all cases following the same pattern: the age segments 18-29 and 30-45 indicated a greater interest than the segments 46-65 and over 65, being the oldest group the least demanding. The variable *MOIA usage frequency* (in this case: more than one use per week, or less than one use per week) is significant in 4 of the 7 requirements in both analyses, 3 of which are common in the two scenarios: the punctuality (daily and weekly users agreed with it 16% more in the "work-study scenario" and 8% more in the "social scenario" than participants with less usage of the service), and the two related to offering a lower price (frequent users valued them about 10% more in both scenarios). For these three requirements, the variable *MOIA user to commute* is also significant in the "work-study" scenario, since it is related to the frequency of use. Also noteworthy is the significance of the *work status* in both scenarios for the time-related requirements: less waiting time and punctuality.

5.3.3 Discussion

The MOIA test service enabled us to identify and analyse the most suitable use cases for on-demand shared ride-hailing services as well as to better understand the users and their requirements. Like the traditional DRT, shared ride-hailing could be used as a feeder service to enhance and complement the public transport system, but also, its flexibility brings other market opportunities which are beneficial to cities, metropolitan areas, and the same operators. In this regard, the use of the service for various purposes at different times of the day would guarantee a minimum occupancy rate and maximise the profitability of the service. Participants used MOIA, mainly, for private trips, but nearly half of them also used it to commute on a daily basis. Therefore, this type of service proved to be also convenient for this use case, which is the most helpful to reduce the number of private cars at peak times. Moreover, a need of a direct and flexible transport alternative to the car was mainly detected in suburban area of Hanover. In this case, some distances travelled were too long to be made by bike and not so long to be made by car, but were difficult to be travelled by public transport.

The main interest for the use of MOIA was for leisure activities and transfers to the airport. The use of the car in these situations could be expensive due to the parking cost, and public transport or the bike are usually not comfortable to transport luggage and do not give a safe feeling at night. Although there is an opportunity for shared ride-hailing to cover these situations, they might require different service characteristics to fulfil the target users of each use case. In particular, we found that both the intention of use and the user requirements depend on the participants' age and frequency of use of the service. In general, the younger the participants and the more they used the service, the greater their usage intention in the proposed use cases and their interest to improve the mentioned service factors. It is worth noting that the main improvements requested by the users were related to the reliability, availability, price, and time.

To summarise, the core characteristic of shared ride-hailing that distinguishes itself from traditional DRT is flexibility. Until now, this flexibility is found, mainly, in the way of booking, the route followed, and the determined stops. If other features such as waiting time, walking distance and price could also be adjusted for each use case and target user, considering external factors like weather or strikes, a significant increase in the use of this type of services might be reached.

5.4 CONCLUSIONS

The results of these two case studies proved that there is a big interest in using app-based shared ride-hailing services once citizens have already tried them. Therefore, pilot tests are necessary to both familiarise target users with these services and to be able to detect market niches and study the user requirements.

Although the first case study was based on a small scale one-week commuting pilot (Barcelona's pilot), it enabled us to provide preliminary conclusions to further investigate in the second case study –conducted some months later in another European city (Hanover)–, and which was broader both in number of participants and in scope of the service provided (length of the test service, service area, and operating hours). And certainly, the second case study confirmed the main use cases and user requirements identified in the first.

Thus, both studies identified that shared ride-hailing services could be a suitable means of transport, from users' point of view, for regular commuting and leisure trips and also for occasional trips such as going to/from the airport and going to the doctor. These studies also revealed that the intention of use in the different situations presented differed, mainly, according to the age, accessibility to the private vehicle, and the frequency of use of the service (considered in the second case study) of those surveyed.

Focusing on the commuting use case, we found out that participants of the Barcelona case study would mainly use shared ride-hailing as an alternative to public transport –notice that the service area in Barcelona was very restricted and easily reachable by city bus, underground and tram–. The private car was not much used in this case, since, in addition, the covered districts are frequently experiencing traffic and parking problems. Compared to public transport, Barcelona's pilot was more convenient and comfortable: users could go directly to the destination without transfers, had a guaranteed seat, and the pick-up and drop-off sites were closer. On the other hand, participants of Hanover's study would also use the shared ride-hailing service to substitute the car. And in both cases, users agreed that the services tried could be an alternative to the bicycle and the motorbike when the weather was bad.

Concerning the service characteristics to become frequent users of a service such as those tested, participants required the service to be, first of all, available, reliable, and safe. The next important characteristics were related to the price, travel time, and convenience (i.e. direct trips without transfers, integrated with the public transport fare system, punctuality, and shorter waiting times and walking distances to the pick-up and drop-off locations). And lastly, with the exception of cleanliness, comfort features were less valued. This aspect may not have been given as much importance by interviewees because they appreciated that the comfort provided by the pilots' vehicles was already sufficient, since were more comfortable than public transport and guaranteed a seat. Although comfort seems, at this moment, to be a non-key aspect to increase the use of these services, it is also an important feature to take into account, since as a whole and in a probable future scenario comfort could be a decisive factor in choosing between competition.

In addition, we noticed that user requirements depended, specially, on the age and service usage frequency of the participants. No significant difference is detected in the importance given to the requirements between the two different scenarios presented in the second case study: work-study and social.

As for the price factor, we detected that users would not pay on a daily basis more than the double of the price of the bus or the underground –but would pay a higher price for occasional or night-time uses–, where these means were available. Likewise, the interviewees considered very important all the requirements presented related to the price: lower price for repeated use and when travelling with more people, having a loyalty card for discounts, and the integration with the public transport fare system. Therefore, considering that the price will be a determining factor for the success of shared ride-hailing services, dynamic prices taking into account the usage frequency and the number of people with whom users travel with might be necessary, unless the price of the service is such that the users would be willing to pay. But low prices could complicate the profitability of these services, therefore partnerships with the administrations, transport authorities, or other third parties might be required to achieve a higher use rate of the service or subsidies to cover particular areas or use cases.

The various uses of shared ride-hailing services will be conditioned by the different stakeholders. Accordingly, the need to study their perspective on the chances and limitations of these new mobility services is detected. On this basis, the following chapter presents the analysis and results of the conducted face-to-face in-depth interviews with the main stakeholders.

Chapter 6. ANALYSIS OF THE CURRENT AND UPCOMING MOBILITY ECOSYSTEM FROM THE PERSPECTIVE OF KEY STAKEHOLDERS

Emerging mobility services face several challenges, not but least the fact that there is still no clear regulation in many cities as to whether or not they can operate, and how they should do it. In addition, where they are already regulated, the conditions might be different from city to city in even the same country (for instance, most of the carsharing services in Madrid operate under the free-floating model, which is not yet allowed in Barcelona), they are often seen as unfair competition from regulated services, they require other players in the ecosystem to also make changes, such as insurance companies, and they are waiting for the arrival of autonomous vehicles to actually make a profit. These, among other external and variable factors, facilitate, improve, worsen, or block the business models of these services. Therefore, it is necessary to take them into account when designing and implementing mobility services.

The aim of this chapter is to analyse the current and upcoming mobility ecosystem from the perspective of the main key partnerships identified in Chapter 3: local administrations –who regulate the urban space and municipal public transport–, policy makers –who regulate municipal and regional transportation, including taxi and VTC services–, technology providers –who provide the technological systems (apps, platforms, and algorithms) and, therefore, enable more or fewer features–, and insurers –who insure the vehicles and limit what is insurable–. Concretely, we conducted in-depth face-to-face interviews with professionals of these sectors, currently working in the Barcelona area, to gather their points of view on the current rise and future development of shared mobility services from their area of expertise, to assess different business opportunities identified in the course of this thesis, and to find out which are the barriers preventing the proposed business models.

We chose to focus on the Barcelona area for a twofold reason: this thesis includes two case studies carried out in this city, thus it is the area we know the best; and at the time this part of the research was conducted, the Metropolitan Area of Barcelona (AMB), the city of Barcelona, and other municipalities of the area began to regulate the shared mobility services and, also, to pilot other services like the DRT and park & rides.

The name of the experts interviewed, the entities they work for, and their position when we interviewed them are listed in Table 16. We selected a representative of the Barcelona city council (Manuel Valdés) and one of the Sant Cugat city council (Víctor Martínez), as they are two very different cities within the metropolitan area. Barcelona is very attractive for mobility services as it is a high dense city. On the other hand, the city of Sant Cugat is very dispersed, which presents a problem when it comes to offering an efficient public transport system. According to the Idescat (2019) data, the population density of Barcelona is 15,987.6/km^2 and of Sant Cugat is 1,879.8/km^2. Also, we interviewed Guillem Alsina, from the policy maker AMB, which is responsible, among other issues, for the regulation of various transport services in this area. Next, we interviewed the researcher Mari Paz Linares, specialised in optimisation and simulation techniques to transportation problems. And lastly, Jose Tirone, strategic projects consultant in the insurance field.

Table 16. Panel of experts interviewed and position at the time we interviewed them.

Name of the expert	**Position and organisation**
Manuel Valdés López	Deputy manager on mobility and infrastructures, at Barcelona city council
Víctor Martínez del Rey	Director of territory and urban quality, at Sant Cugat del Vallès city council
Guillem Alsina Martí	Head of the planning service and studies, at AMB
Mari Paz Linares Herreros	Researcher in the application of optimization and simulation techniques to transportation problems, at Universitat Politècnica de Catalunya
Jose Tirone Toledo	Strategic projects consultant and business analyst, at Zurich Insurance Company Ltd

The chapter is organised as follows: first, the methodology employed in designing and conducting the interviews is described, then, the analysis of the interviews is presented, and finally, the discussion and conclusions of the conducted research are provided.

6.1 METHODOLOGY

The interviews were designed with the aim of understanding how the cities plan their urban mobility model, integrating the on-demand shared mobility services and also the opportunities that technology offers, such as turning buses into DRT; and to identify opportunities and limitations that on-demand shared mobility services could have when adding more value to their current propositions, either from the cities where they want to operate as well as from technology and insurance providers. The questionnaire was semi-structured and divided into blocks, as follows: first, the purpose of the interview was introduced, within the framework of the present thesis; next, specific questions of the respondents' area of expertise, mainly related to the emergence, evolution and potential of app-based car-related shared mobility services were formulated; and then, some questions related to assessing the complexity of a number of business opportunities were asked (Figure 33).

The interviews were conducted between February and March 2019, in Catalan and Spanish, were face-to-face, lasted between one and two hours, and were recorded for a better post-analysis, with the consent of the interviewee.

To organise and analyse the qualitative data, coding according to grounded theory was conducted (Flick, 2009). The interviews were transcribed and text data was organised with the software tool Excel.

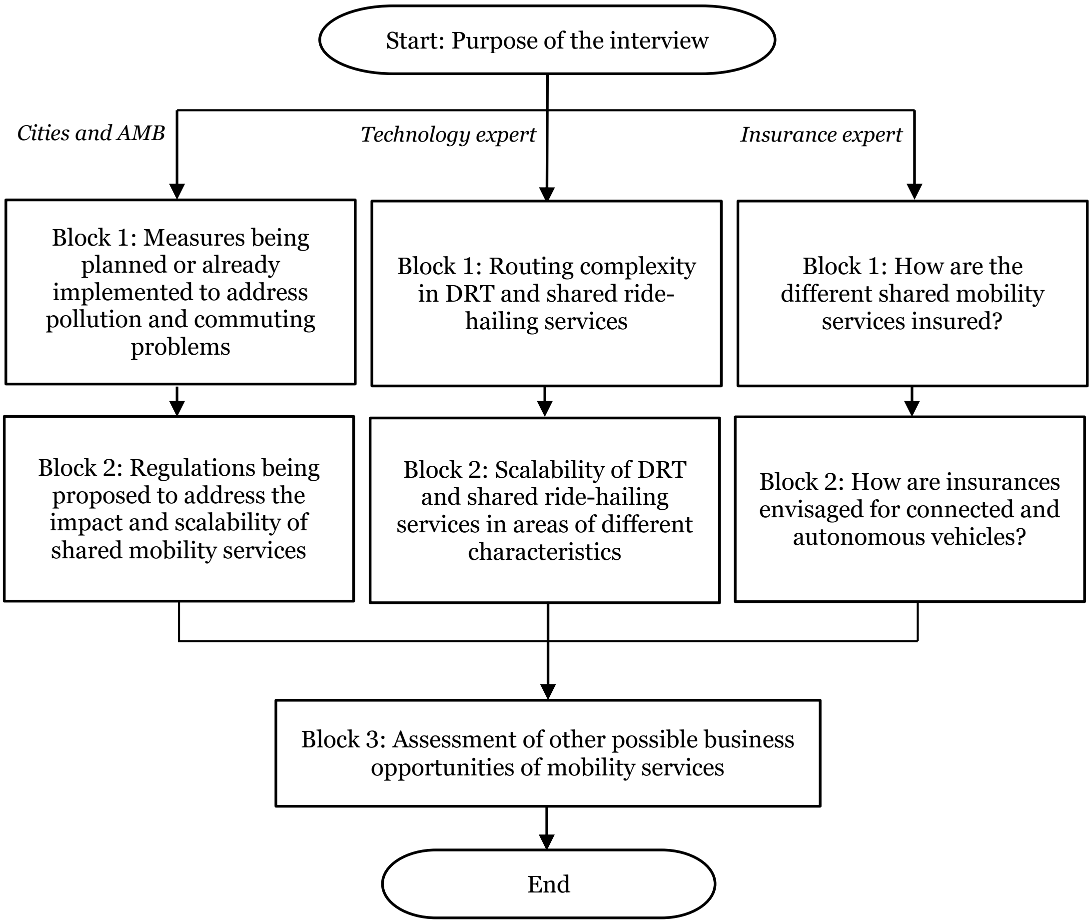


Figure 33. Structure of the interviews with experts.

6.2 Analysis of the interviews

The analysis and comparison of the results has been carried out by clustering the responses according to the categories and codes presented in Figure 34. As shown in Figure 34, data was organised into six codes, which were grouped into two categories: Urban mobility model and Shared mobility services. "Urban mobility model" focuses on existing public services, which have the potential to improve and become more efficient and more attractive to users. "Shared mobility services" focuses on the key issues related to the barriers and opportunities that car-related mobility services face, in particular, carsharing and ride-hailing services.

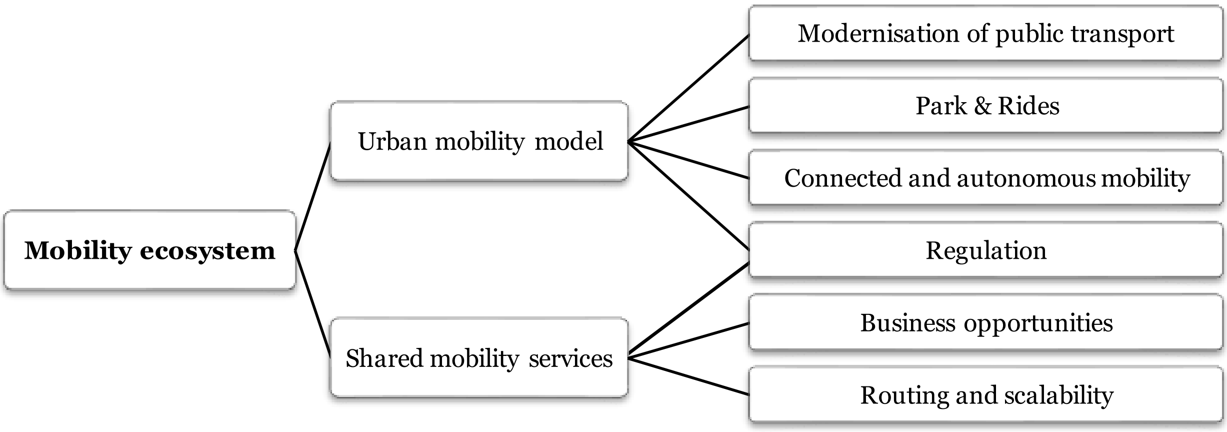


Figure 34. Structure of the coded data.

6.2.1 Urban mobility model

In the words of Manuel Valdés, *"the way people move around defines the city model"*. According to him, the different entities and institutions must act in harmony to ensure that all modes of mobility are coordinated, *"because without coordination, the model does not work"*. In this category, we explore the city and region model that the public administration is envisioning, at a time when efforts are being made to improve the air quality of cities and the arrival of autonomous vehicles is expected.

The category is organised into the following 4 codes: Modernisation of public transport, Park & Rides, Regulation, and Connected and autonomous mobility. The analysis is presented in the format of question and answer.

Modernisation of public transport

Why are you piloting DRT services?

Sant Cugat, a city with a highly dispersed population, is considering converting several regular bus lines to DRT after the success of the DRT pilot in the neighbourhood of Can Barata[40]. In this town, the main problem of the current bus system is that it covers every area, but inefficiently (i.e. low frequency and long routes). Consequently, the usage rate is low and the majority of users are older people who do not care about the trip duration, and the rest of the inhabitants use private means. Víctor Martínez considers that it might not be necessary to cover every area and that priority should be given to reaching the places with the highest demand, such as the health centre, the train station, or the city centre, as the current DRT.

In Barcelona, the DRT pilot covering the neighbourhood of Torre Baró[41] is also going well. It works as in the case of Sant Cugat with pre-fixed stops, but without pre-fixed routes, picking-up and dropping-off passengers throughout the entire covered area. Manuel Valdés considers that this service makes sense when people are very dispersed and the conventional itinerary is not what is needed. But it is

[40] For more info, see: https://www.santcugat.cat/web/tad-canbarata
[41] For more info, see: https://www.tmb.cat/en/sobre-tmb/millores-xarxa-transport/altres-millores/el-meu-bus

also an opportunity if the service attracts many users to then implement a conventional line covering the most frequent routes.

DRT services are also being implemented in other locations of the metropolitan areas, mainly in locations with low population density. According to Guillem Alsina, the aim of this modernisation of public transport is to provide the maximum available coverage with a public transport fare.

What challenges are found in the implementation of a DRT service?

Guillem Alsina explains that, as the route of the DRT buses are not pre-set, the entities who tender this transport option need to control the requests made to ensure that the DRT service is covering them following the most efficient routes.

Another challenge facing the on-demand service is the coexistence between real-time bookings and pre-bookings. For instance, the DRT service in Torre Baró is required to accept both types of bookings. As stated by Alsina, this situation is not well suited, since it can occur that a request to take a passenger to a certain point has been confirmed and that there is at that moment a greater demand in terms of number of passengers in another distant point. And it may also occur that a single person monopolises a route every day at a certain time, meaning that, if only one bus is available, other users willing to travel to other sites would not be able to access the service at that time.

Concerning the pre-booking option, either for DRT, taxi, or ride-hailing services, the risk generated is that the system becomes vitiated if everyone books in advance, and if the service can be booked hours in advance, the risk is even greater –since these pre-bookings could occupy all seats–, explains Mari Paz Linares. Hence, the operator is given the certainty that the maximum occupation is reached, but the business is transformed because it stops being on-demand. For Linares, if real-time bookings have to be compatible with pre-bookings, it would be essential to reserve a part of the fleet for the real time; otherwise the mixed model would not work.

Also, Linares states that the efficiency of "matching" (meaning the grouping of users requesting a ride in the same direction at the same time) both for DRT and shared ride-hailing services depends on the demand. To operate in a place with a lot of demand it would be necessary to have a large fleet. If there is low demand in a very large space, the dispersion inhibits grouping. Should only a small fleet be available, the targeted places should be small and specific, such as the DRT of Sant Cugat and Torre Baró. In addition, for the matching, the time window parameter is decisive, since the capability to group users increases or decreases accordingly.

What improvements in public transport help to improve the traffic due to commuting?

Manuel Valdés explains that the public transport service that enables users to reach their destination with only one transfer should be the commuting system. Regarding Barcelona's bus service, the new bus network that is being implemented in the city allows users to reach any point in the city with a single transfer, which is very important, according to Valdés, since if one needs more than one transfer, the service is no longer used. Therefore, it is considered that this strategy should be extended to the entire metropolitan area.

Regarding the metropolitan area of Barcelona, Guillem Alsina comments that the AMB is trying to improve the regular bus service of other municipalities in the metropolitan area by increasing its frequency of service and the number of stops.

What improvements does the taxi need, in view of the decrease of clients they claim to have after the arrival of VTC services?

Valdés and Alsina agree that taxi service is a must, but to continue existing some necessary measures to modernise it are required –by taking some of the characteristics of the VTCs, which are competitors and use a more intelligent platform– without losing its essence. For instance, the taxi service could evolve to offering a fixed price and shared trips. As for the possibility of establishing a single dispatcher for taxis to match all the demand in an optimised way, both experts state that it raises a problem of competition, since there are already some private companies that manage the demand for taxis. However, Alsina adds that there could be a single public application that derives the requests to private dispatchers.

Additionally, Alsina explains that the AMB –entity on which taxis in the metropolitan area of Barcelona depend– launched an application that gives the estimated price of the trips, and many taxis already assume the commitment of this price and not the one marked by the taximeter. And that the possibility of sharing the rides in the taxi is coming soon. He considers that shared rides will have to be priced differently, but taking into account that the taxi is not a public transport as the bus or the underground.

On the other hand, Valdés thinks that taxis should not move to find clients and, for this reason, the Barcelona city council is working on introducing taxi micro-stops every two crossings.

Park & Rides

How is the park & ride solution adopted to promote entering by public transport to Barcelona?

Apparently, the implementation on the outskirts of cities of dissuasive parking lots with accessibility to public transport connecting the city centres or various districts of the cities would be a solution to reduce the commuting traffic. However, Alsina manifests that Barcelona's neighbouring municipalities do not want to become the car park of Barcelona. These municipalities encourage their neighbours to use the train and park their cars at the train station, but do not support inhabitants from other municipalities parking there too, explains Alsina. And Barcelona does not have enough empty space to build this type of parking lots in the city itself. In spite of this, AMB is promoting small park & rides –from 50 to 150 parking spaces– located near the train stations of municipalities near the Catalan capital, which have a high frequency of public transport services that connect with the capital. Alsina considers it essential to locate the park & rides where the train is for capacity reasons and because the bus is not as efficient due to the lack of bus lanes to enter the city.

On the other hand, Sant Cugat –10 km far from Barcelona– is unintentionally turning into the park & ride of Barcelona since its fare zone changed from 2 to 1, as such, the demand for parking near their train stations is increasing. Martínez explains that, not for this reason but with the aim of reducing traffic in the centre of Sant Cugat, a dissuasive car park with 800 spaces and a shuttle service that connects to the city centre every 10 or 20 minutes have been set up, and that there are plans to create more car parks with the same objective.

Regulation

How is the restriction of the most polluting vehicles being managed, which was estimated in 2017 to affect 25% of the fleet of vehicles circulating in the metropolitan area?

Valdés explains that this restriction is being accompanied by measures such as an increase in the metro and bus fleet and the remodelling of the bus network, which now enables longer-distance exchanges.

Likewise, the municipalities closest to Barcelona that were in the second metropolitan zone are now in the first, which means their inhabitants can travel by public transport more economically. Martínez comments the case of Sant Cugat, where they have detected that residents of the second zone travel by private vehicle to this town –which now belongs to the first zone, and where free parking is available– and commute the last mile by train, instead of directly taking the corresponding transport service in their locality, if it exists.

Has it been contemplated to establish a congestion charge like the one in London to limit the entry of cars into Barcelona?

Alsina thinks that metropolitan tolls should not disappear, because setting a new toll is very difficult, and these existing tolls are already a measure that helps to prevent more vehicles from entering this area. According to him, the meaning of these tolls should not be to pay for the use of the infrastructure, but to regulate the entry of vehicles into Barcelona. And, for this reason, these tolls could have some bands with higher prices and others with lower prices, or even no cost, for example at night or on weekends.

Connected and autonomous mobility

What changes are expected in a future where vehicles are autonomous and connected?

Alsina believes that the future of mobility cannot be based on autonomous cars, but mass collective transport. He states that when there is rail transport, it must be rail transport, since the buses have neither the capacity nor the frequency of the train and subway. And when it is not possible or rail transport is not sufficient, then the bus services are required. In the words of Alsina, what is not permissible is having users with electric and autonomous cars and all modes stopped.

Concerning future changes in insurances, José Tirone explains that instead of insuring vehicles, it could be that only people were insured. For him, it is clear that insurance options are evolving towards a flexible and on-demand model, and that big data would enable this new type of "pay as you drive" insurances. Theoretically, though, once the entire fleet is integrated with autonomous and connected vehicles, accidents would disappear, but to the question of whether in this scenario insurance would be necessary, Tirone responds that it is not contemplated that they can be dispensed with. However, he points out that this expected evolution of vehicles and the emergence of mobility services lead insurance companies to consider parallel businesses and to move towards services for third parties, such as mobility services.

6.2.2 Shared mobility services

The transformation of urban mobility after the emergence of on-demand shared mobility services is global, but for the time being, it only affects the densest cities. In this category we analyse the public administration perspective on the emergence of these challenging services that disrupt the traditional mobility ecosystem.

The category is divided into the following 3 codes: Regulation, Routing and scalability, and Business opportunities. The analysis is presented, as in the previous subsection, in a question-answer format.

Regulation

What is the objective of regulating the activity of the new mobility services, and how do you regulate them?

Valdés considers that public institutions have an obligation to ensure a balance between mobility systems, since there is a risk that if everything is left in hands of the market, companies will end up deciding what the mobility of the city will look like, allowing cities to lose the attractiveness of the future, as decisions will be taken following a business logic and not one of coexistence, nor of guaranteeing the mobility of all people.

Therefore, as stated by Alsina, it is essential to regulate in the field of shared mobility services, since currenlty, providers of these services want to offer their services only in Barcelona, and at the most also in L'Hospitalet de Llobregat, as these are the two most populated municipalities in the metropolitan area. Also, Alsina affirms that the aim of Barcelona in regulating this topic is not to prevent services from being provided, but rather to ensure that there is a rational use of public space.

In the field of carsharing, Valdés explains that the most notable aspect for Barcelona is that these services cannot occupy parking spaces on the road surface. For this reason, the city hall is preparing a regulation that requires operators to specify where the vehicle is parked at all times and opens up the possibility that for part of the time they could be parked on the surface. Furthermore, Valdés announces that the use of electric vehicles will be required, but on the other hand, the requirement to cover all neighbourhoods is discarded, as it is considered that the services offered will self-regulate according to demand.

For other means of transport, Barcelona has set a fee for private bike and scooter sharing services that occupy public space, states Valdés. As for one of the most fashionable means of transport at present, the e-kick-scooter, he explains that the activity of offering it in the public space has been prohibited for the time being with the aim to prevent the proliferation of vehicles parked throughout the city that create problems for pedestrians and occupy bicycle parking spaces. However, he adds that the city hall is planning to regulate this sharing activity in the near future.

In the opinion of Valdés, the vehicle sharing –either cars, bicycles, or motorbikes– is beneficial for when public transport is not needed, if well regulated, serves to complement public transport, and does not become an invasion. He finds it a very good option for citizens to move from owning their own car or motorcycle to renting the necessary vehicle only when they really need it. As he stated, the interesting point is if there is no obligation to return the shared vehicle to the same place, users can make part of the trip or the return on foot or by public transport.

With regard to VTCs, regulation has been changing in recent years. Alsina highlights that all vehicles with 9 seats or less are taxis or VTCs, and that vehicles with more than 10 seats are considered public transport. He explains that, at first, VTCs were for very specific services, such as for hotels or trips planned in advance, but the popularisation of certain apps, such as Uber, have turned them into a service very similar to taxis. In response to this situation, the Catalan government established a ratio of one VTC licence for every 30 taxis. But the Spanish supreme court annulled it and determined that it was a liberalised market. In a matter of days, thousands of licences were granted until another sentence determined that a ratio could be established, and the market was closed again. In summer of 2018, the Spanish government left the legislative power over VTCs in the hands of the autonomous communities and, in Catalonia, the government issued a decree establishing that VTC services must be contracted 15 minutes in advance, giving local authorities the possibility of extending it to one hour. In this way, and with the aim of differentiating this service from that of taxis, Barcelona and AMB regulated that a VTC has to be ordered sixty minutes in advance, in addition to obliging operators to return the vehicle to the base after each service.

Another of the current debates in Barcelona and the AMB is whether the VTC services should be regulated or the taxi should be deregulated. Alsina thinks that with the regulation and licensing to offer the service, the administration can establish a whole series of conditions, including which vehicles are approved to offer the service (and thus avoid diesel and gasoline), force to accept credit cards, and set price ranges, among others.

How are the new mobility services insured?

Tirone explains that standard insurance does not cover economic activities carried out with vehicles, and therefore, to conduct these activities, additional insurance for people is required, but not for vehicles. As for ride-hailing services, he informs that, according to the current regulation, a standard insurance plus an extra complementary policy for the transport of passengers is required.

For carsharing, in the opinion of Tirone, a distinction could be made between one-way and round-trip services, but this is not currently the case. If this differentiation was made, he notes that some particular aspects could be taken into account, such as the fact that in one-way the vehicle is parked in the street, but this is not a common practice in round-trip services.

Routing and scalability

A key design factor that ride-hailing services face is routing. What is meant by routing?

Linares explains that the routing algorithm solves any problem involving a demand to be served by a fleet of vehicles. And that among the variables that influence the algorithm, we find the type of fleet: homogeneous or heterogeneous –vehicles are the same or different, for instance, in terms of more capacity (seats)–; and whether the demand is static or stochastic –it is known from the beginning or it appears during the day.

Additionally, Linares describes the vehicle routing problem, which starts with deciding the restrictions and the objective function (i.e. if the objective function is to minimise the time in circulation of the fleet, the algorithm will manage the requests in such a way that this time increases less). Then, other parameters, for example pick-up and drop-off distance, waiting time, and time windows are added. According to Linares, depending on the business and type of transport, it will be necessary to prioritise some parameters or others. Thus, Linares notes that time windows are narrower for passengers than for goods. And if time windows are very narrow, it might be complicated to add new passengers to the same service, or in the middle of two services.

In the opinion of Linares, the main handicap of the routing algorithm is that the time-cost subject is not well resolved, so the final cost issue is not well solved either. These algorithms usually work based on historical data, information from Google Maps, or based on traffic forecasting through machine learning of the fleet.

Is it possible to define a service in which parameters such as access length, passenger capacity, and waiting time are flexible (i.e. could change during the operating hours)?

Linares confirms that this is feasible. She points out that both virtual stops and radius can be defined and that different algorithms for specific causes can be prepared, so that each of them is activated when it is most convenient.

What is more efficient, a model with the possibility of pick-ups and drop-offs during the whole trip, or pick-ups and drop-offs concentrated in an initial zone and in a final zone?

Linares states that the first model works if the capacity is high, and the second model provides the certainty that the transport is shared for most of the trip, as in the case of the Sant Cugat DRT.

What factors should be taken into account for the scalability of a DRT or shared ride-hailing service?

The fleet and demand are closely related, highlights Linares. She comments that if there is high demand and large fleet available, many rides can be grouped together. But if the demand is very dispersed, it is difficult for the service to work properly. In any case, for a DRT or shared ride-hailing system to be scalable in a dense city like Barcelona, many requests from travellers sharing origin and destination are required, according to Linares. Linares provides the example of Kutsuplus –service that failed because its fleet could not be expanded, which prevented the service from increasing its demand, which was very dispersed–, and remarks that with a fleet of minimums it could neither cover the whole city nor do business.

Furthermore, she notes that denser and less dense areas cannot be equally addressed. In the opinion of Linares, ideal would be to have different algorithms that are activated in different situations.

Business opportunities

Is it likely that the public administration becomes a user of carsharing and ride-hailing services to start reducing its private fleet of cars?

One detected opportunity for carsharing is the corporate use in addition to the personal use, to achieve a higher use rate of cars and a greater benefit for their operators. In this sense, Valdés explains that the city council of Barcelona is already planning to use carsharing services to substitute their renting corporate fleet. Also, Martínez points out that Sant Cugat city council staff used the carsharing service Avancar –as the municipal car fleet was small–, until the service closed.

What mobility services could help improve commuting traffic?

According to Valdés, in less urban areas vehicle sharing could make a lot of sense if the round-trip option is enabled at certain times. For example, a car or motorbike could be taken at night (when in the city there would be less demand), sleep in another municipality, and the next morning the user returns it (for a reasonable price). This would be a deferred round-trip. Another example he gives is that of a bike or e-kick-scooter parked at the train station, at night the users could take them home, and the next day return them to the station.

Have you considered the option of a VTC service (or alternatively taxi or DRT) covering the lines with low use of night public transport? As happens in cities like Brussels, where users who request the service at night and at bus stops (in this case taxi), pay a subsidised fare.

It is not considered that on-demand mobility services could replace the current night buses or the underground at night, when this public transportation is economically inefficient. Valdés argues that public transport is a public service, so it should not depend on profitability and should also be robust during off-peak hours. Alsina considers that the AMB night buses have enough demand. And Martínez states that, in Sant Cugat, there is no night bus, and that with the DRT during the daily hours is sufficient.

Could shared mobility services have different uses, such as combining passenger transport with parcel delivery? Thus, vehicles would be less time inoperative and occupy fewer parking spots.

Valdés points out that delivery companies expect the council to finish regulating the scooter sharing so that their staff could use these vehicles to deliver, and this opportunity will also make sense for carsharing. For Martínez, goods that are not supermarket supplies should be delivered in small vehicles. This way, park & rides could be used as a place to receive these goods, which should be distributed for the last mile in small cars. In this regard, the possibility of uisng the boots of the carsharing vehicles as package stores, or that these vehicles become mobile mailboxes, perhaps at night, when there is less demand and traffic, is detected. However, Valdés states that the use of public car parks for activities other than parking is not permitted, and that a legal modification of the general urban plan would be required.

According to Tirone, the use of shared mobility services for additional business activities requires an extra policy, since the current standard insurance conditions for these vehicles are for people transportation. He specifies that one insurance covering the vehicle sharing activity and another one covering, in this case, the parcel delivery would be required.

As for mixing different types of demand in a ride-hailing service, Linares explains that these combinations are feasible, since the algorithms work with subsets of each of the sets. Therefore, if the incoming request has special characteristics, the algorithm adapts. In the case of combining passengers and packets in the same trips, she specifies that both types of demand have different time windows. In addition, Linares wonders if people would even like to share the journey with packages with unknown content. In her opinion, if the same operator manages the different uses, these could be switched during the day, so that the most convenient is always active.

Would it be technically feasible for individual and shared ride-hailing services to be combined (like the ReachNow service in the United States), or for carsharing to become a ride-hailing service when the demand for carsharing is low, or in areas where it is low?

For Linares, these combinations of uses are theoretically absolutely feasible. In the case of combining singular and shared ride-hailing, a platform to distribute the demand according to the type of requests that drivers desire to receive (only singular, only shared, singular and shared) would be required. Linares explains that, in the same way, the users that want music or not could also be separated, for example. In her words, this is about adding attributes. However, she warns of the risk of the model becoming so restrictive that it is no longer viable. Referring to the combination of carsharing and ride-hailing services, Linares adds that, apart from legislation allowing it, this service could be complex to operate and perhaps it would not be so useful.

Tirone believes that, with regard to these combinations of uses, insurance should evolve. He specifies that, as in the case of parcel delivery, insurance for each type of business would be required. Furthermore, he believes that insurance could be taken out on-demand (i.e. the vehicle is covered by the standard insurance, and the civil liability would be subscribed at every rental operation taking into account the concerned driver). For this to be possible, he notes an integrated and connected ecosystem should be in place: as soon as the vehicle door is opened, the complete insurance linked to the person who would drive the vehicle is activated. According to Tirone, the existence of this type of specific products would be possible, but at the moment they are not commercialised because an excess of private information would be revealed.

6.3 Discussion and Conclusions

The conducted interviews reveal a number of important aspects to consider when designing an on-demand shared mobility service. First is that the stakeholders interviewed are enablers and restrictors of the development and evolution of these service and of the type of service they can offer. Technologically, no limitations exist regarding the combination of uses or the flexibility of the type of service (e.g. the service changes its business model during off-peak hours). In the insurance sector, it is noted that the sector is changing in order not to become a barrier and it might offer adjustments in their value propositions such as setting the prices depending on the use of vehicles, being interesting at present for carsharing and scooter sharing providers, whose vehicles have a rather low use rate. Cities do not intend to limit, but they do not want an uncontrolled invasion either. They want the right number and type of services to cover the demand, and in this way also guarantee business of those who are already there. As a result, the services arriving later with the same business model as others who are already present will find more challenge in achieving administration approval.

Public administrations believe in public transport and that this should be the basis of citizens' mobility, thus they are also interested in efficiency improvements and more accessibility with last-mile sharing and park & ride services. In the specific case of Barcelona, it is stated that if there were high occupancy vehicle lanes at the entrance of the city (currently there is only one), park & rides could also have an efficient connection to the city by bus. Therefore, the possibilities of placing a parking lot of these characteristics would be increased. Lastly, it is evidenced that if the offered options are practical (save time and money) –as in the case of parking in Sant Cugat to then take the train– people use them.

Hence, coordination among all the mobility operators and transport authorities is required. In Barcelona, public transport currently has an integrated fare that facilitates intermodality and multimodality, since all the city public transport means are accessible with the same ticket, which includes transfers for a given period of time. However, at the moment, in Barcelona and in many other cities, public transport is not integrated with private transport, so the same card cannot be used to book and pay for private services.

Going towards a MaaS model (with or without a flat rate) would help to encourage the most convenient transport at all times (i.e. public transport for most of the trip and the bicycle or kick-scooter for the last-mile). In this regard, a single concentrator of vehicle sharing services and a single dispatcher for taxis and VTCs could make sense. This possibility should be further studied to ensure that it neither generates a competition problem for current dispatchers nor that the different services operators lose the relationship with customers.

Concerning the DRT, it is seen as a particularly interesting option for low density areas and also for areas with low bus use rates to detect the routes people travel and, if there is sufficient demand, establish a regular bus line for the route identified. The implementation of a DRT service is not trivial and, among other parameters, it must be decided if, apart from being on-demand, the service will also accept pre-bookings. Depending on the available fleet, this functionality should be limited so as not to collapse the service.

At the same time, the VTC services are seen as competition to the taxi, which bring added technological value and enable other type of uses, such as sharing the trips with other customers. These characteristics could also be implemented in taxis and, in fact, the taxi sector is slowly adapting to this changing situation. In this direction, in Barcelona we can already find the ecotaxi[42] and ntaxi[43] apps, which enable the reservation via app of the service, give price in advance, and ntaxi also enables the sharing of the trip and its cost. It is also noteworthy that the regulation of VTC services is not steady and that it can differ among countries and cities of the same country.

As for business opportunities, there is a consensus that new business models have to appear to introduce other uses to the services, as they are still not being used much. One proposal would be to combine the use of corporate carsharing and scooter sharing with private use, and thus give a use to vehicles for most of the day. With this combination, these services could also become economically viable in smaller cities. Another option for off-peak hours could be to make the area of operation of these vehicles more flexible, as long as the vehicles were returned to the established area on time. Also, the combination of private use and home delivery seems to fit both for the sharing of scooters and cars.

Cities need to organise the urban model they are aiming for before autonomous vehicles arrive, taking into account the automation of vehicles is not only an opportunity for the shared mobility sector, but also for the improvement of public transport, and particularly, for the DRT.

In summary, the enablers of this type of services are, certainly, the technological stakeholders, since services emerge and improve as technology advances. Insurance companies can also facilitate the deployment of these services by proposing insurance models adapted to the use rate they have, and also to the driving experience of their users, among other possibilities. And the administration is as well in some cases enabler of these services, with the development of policies aimed to complement public transport, such as giving incentives to shared mobility services to reach areas uncovered by mass transit or operate during non-operational public transport hours; implementing these services together with park & rides; integrating them into the public transport fare system –to at least enable users to take and pay the services with the same card– or in a potential MaaS public system; and being the administration user of these services.

In reference to the barriers, we find mainly those of the administration. These are prohibitions –not allowing the operation of the services under any circumstances– or limitations (e.g. type of license required, maximum number of vehicles and type of vehicles that can be operated, and parking areas to be used). In the case of Barcelona, the regulations that are being applied tend to impede free trade, when the market could self-regulate, as without enough users for the existing services those who lose money would leave. But the city fears that these services could appropiate public transport users and worsen traffic problems. However, in general, regulations are adjusted over time depending on the

[42] For more info, see: http://taxiecologic.com
[43] For more info, see: https://www.ntaxiapp.com

needs of the city and its inhabitants. When these services help remove private cars from the city and reduce traffic problems, they would be seen as positive players and regulation might adjust to the new scenario.

Nevertheless, the most important barriers that services face come from users and operators themselves, although they are related to the business model with which the services can operate, which is mainly defined by the corresponding policy maker and local government. This way, if users find the services not convenient for them, they will not use them. And if services are not profitable enough, operators will not offer them.

Chapter 7. CONCLUSIONS AND FUTURE LINES OF RESEARCH

Shared mobility services are challenging many traditional sectors, such as the automotive industry, public transport, and car rental and taxi services. In view of their success –they are growing day by day in number of users, although for the moment, not yet in profits–, many of these more traditional sectors are also interested in becoming providers of app-based on-demand shared mobility services. For instance, public transport operators are implementing DRT in some particular areas, car manufacturers as well as rental companies are launching and partnering with different shared mobility services, and the taxi sector, in view of the competition arising from VTCs, is starting to offer the ride service also bookable through applications and on-demand.

Additionally, automotive OEMs have the leading role in developing the vehicles of the future (i.e. connected and autonomous), highly awaited by car-related shared mobility providers, which hope that with their arrival they will start getting significant profits. However, cities fear that these services take users away from public transport rather than complement it, worsening their mobility problems. Thus, cities have a role to play in managing the expected impact, which can neither be left to chance nor forced.

In view of these recent and future changes, and given the importance of many players in the mobility ecosystem, the need to study the business models of these emerging services, the ecosystem, and the requirements of potential users is detected to identify how these business models could enhance their economic efficiency as well as being more attractive to cities and their inhabitants.

In this thesis we studied the business models of car-related shared mobility services, and in particular of shared ride-hailing services, at a time when they started operating in European cities. First of all, we reviewed the global trends challenging the mobility sector and the automotive industry, and studied the current mobility ecosystem and its expected immediate future. We found out that in these new business models, companies do not compete individually, but with strategic partnerships and alliances. We identified how different mobility providers, both large and small, create collaborations between them, with the cities, and with other stakeholders to be able to improve their services, expand them, and move forward faster than other players.

The players in these ecosystems are different between cities, since in each city local actors such as public transport authorities and operators are involved. Therefore, to have a complete view of one ecosystem, it was necessary to focus part of the research on the same city. Barcelona was chosen for being one of the most populated and densest cities in Europe, which are the ones with the greatest concern for reducing the volume of traffic and the level of pollution. Thus, three case studies were based in Barcelona. Though, one case study was also conducted in another European city (Hanover), where the legislation is not so restrictive and allows the operation of shared ride-hailing services.

Secondly, we analysed the information available from the literature focused on business models of app-based car-related shared mobility services, from current operating services, and from short interviews with users and drivers. This analysis enabled us to distinguish the common features and differences of carsharing, ridesharing, and ride-hailing services, and understand that they are not interchangeable but complementary from users' perspective. We found out enough similarities (common characteristics are identified in the 9 building blocks of the Business Model Canvas) to suggest that aggregated offer providers could not only share some key and costly resources and activities, but also the channels, customer relationships, and key partnerships. And sharing these resources and activities would enable unprofitable services (as stated previously, most services are) to be profitable.

Then, we studied the mobility patterns of the inhabitants of the Metropolitan Region of Barcelona and their usage intention of app-based car-related shared mobility services in different situations to identify the profiles of their potential customers. We found out that most of the interviewees were very multimodal/intermodal; that these services were still considerably unknown to the inhabitants; for their use, the pay per use model was preferred over the flat rate; and citizens up to 29 years old were more interested, in general, in using these services, and concretely those that do not involve having to drive.

Furthermore, we conducted two case studies focused on shared ride-hailing services under the hypothesis that when autonomous cars arrive, the carsharing service will turn into singular ride-hailing and ridesharing into shared ride-hailing. Also, shared ride-hailing will continue being a more sustainable service than singular ride-hailing. These studies showed that there is a big interest in using app-based shared ride-hailing services once citizens have already tried them, and in particular, in suburban areas; confirmed that shared ride-hailing services could be an alternative to private cars for commuting, specially for the trips made by public transport that require transfers; found the other use cases that this type of service has: leisure activities and transfers to the airport; noted the importance of the price for users to become regular riders, which should not exceed twice the price of the bus or subway, as well as other key design factors, such as the availability, reliability, and safety; and identified the usage intention and user requirements that depended on the users' characteristics. It is worth noting the identified opportunity to create a service where parameters such as waiting time, walking distance, and price could be adjusted for each use case and target user, also taking into account external factors like weather.

Finally, we analysed the current mobility ecosystem and future opportunities to improve it, from the view of key stakeholders. We identified that the future could involve having a MaaS that promotes the use of public transport as a backbone and complemented with last-mile services. Also, that new business models for shared mobility services have to appear, for these services to become profitable. And that all these business models will need to face, mainly, legislative barriers.

The conducted research, which included a total of five case studies of different characteristics, enabled us to cover the defined objectives and answer the main research question and the four specific sub-questions posed at the beginning of the research process. All the case studies were related to some of the research questions, and this methodology enabled us, at the end of each case, to answer part or the whole of the corresponding question or questions. These case studies were conducted sequentially, which also enabled the following case study to complement the results of the previous cases. And the main research question could be answered at the end of the five cases.

Next, we summarise the main findings related to each research question.

RQ1: What use cases do car-related shared mobility services have?

We identified that the main use case of car-related shared mobility services is the direct connection to places of special interest from areas with less access to public transport. Moreover, other use cases with the highest intention of usage by type of service are:

- Carsharing: day trips.
- Ridesharing: occasional long trips.
- Singular ride-hailing: night leisure trips and airport transfers.
- Shared ride-hailing: day and night leisure trips, airport transfers, and commuting.

RQ2: How are potential users of car-related shared mobility services?

The profiles of the potential customers of these services are the following:

- Inhabitants already experienced with shared mobility services (e.g. bike sharing).
- Intermodal inhabitants, who could avoid transfers and waiting times.
- Younger population, with the exception of the carsharing service that is more attractive to citizens over 30 years, and of which the usage intention is higher with increasing age.

In particular, we found out that the target market of shared ride-hailing services to commute consists of commuters of 5-10 km, citizens without a driving license, and those living in the outskirts of the city or in neighbouring villages.

RQ3: What are the user requirements for a frequent use of shared ride-hailing services?

We detected that the main factors to be considered for the service design of shared ride-hailing services, from users' perspective, are:

- Pricing: pay per use with discounts for recurring usage and when travelling with more people, and integration with the public transport fare system if possible. From a business point of view, it would be interesting to apply dynamic pricing, which in addition to adapting to the frequent use and the number of people in the booking it would adjust depending on the origin and destination of the trip –being less expensive those routes that attract more users and are easier to be shared–.

- Availability and reliability: users want a service that is bookable when they need it (during the operating hours) and, to make sure of it, they ask for the pre-booking option. In addition, they want to reach their destination on time (punctuality).
- Waiting time: reducing waiting times is more important than shortening travel times.
- Safety: ensure the professionalism of drivers, that users are respectful, and pick-ups and drop-offs are not conducted in unsafe areas.
- Cleanliness: users want to feel comfortable and relaxed in the vehicles, and therefore, vehicles need first to be clean.
- Walking distance to pick-up and drop-off locations: users accept to walk up to 5 minutes, but a door-to-door service is highly valued in situations of rain, carrying luggage, or night trips, among others.

RQ4: How could car-related shared mobility services evolve to be more cost-efficient?

We identified that key resources and activities could be optimised by means of:

- Offering the services in a combined and integrated way, which would enable: 1) the fleet required for each service to be automatically balanced at any time according to supply and demand; 2) higher vehicle use rates.
- Give other uses to the fleet, such as parcel delivery in off-peak hours of the sharing service.
- Sharing the customer service and the technological system among service providers and carry out the maintenance of the different fleets jointly.

In addition, business opportunities could arise by providing key resources and key activities separately to other private or public transport operators, under white label, such as the technological system (solution engine, user and driver applications, and backoffice system) and the vehicles (purpose-built).

Also, business opportunities could emerge from partnerships. We detected the following potential partnerships and opportunities:

- Any mobility service with app-based transport service aggregators, app-based route planners, and MaaS providers: to increase visibility and potential customers.
- Carsharing and ride-hailing operators with delivery companies and online retailers: to deliver goods replacing pollutant trucks and vans.
- Carsharing operators with any entity or company: to provide flexible corporate fleets.
- Shared ride-hailing operators with:
    - Local governments and bus operators: to provide DRT.
    - Park & ride operators: to transfer users to their final destinations and return to the park & rides.
    - Event organisers (e.g. music festivals, football matches, fairs): to transfer customers to the points of interest and return them to the departure locations.

Concerning the barriers to design and implement shared mobility services in an aggregated way or with additional uses, no technological impediment was detected. We identified mainly the following barriers:

- Legislative: affect carsharing and ride-hailing services by limiting the volume (i.e. maximum number of licenses or vehicles) and how they can operate (e.g. type of licences required, parking zones, pre-booking requirement). They can be adjusted over time according to market needs (e.g. more demand than supply is detected or there is opposition from traditional sectors like the taxi). No barriers are identified that restrain the combination of services and uses or the sharing/provision of resources with other operators or interested companies.
- Market-driven: constraints from potential users (for what and how they use the services and how much they are willing to pay), from operators (what and how they are willing to offer and what they are not), and from competition (possible opposition from sectors such as taxi and other transport services).

Legislative barriers as well as those driven by the market –both country and city dependent– can slow down or stop some interesting use cases. For instance, in Spain we do not find shared ride-hailing services such as MOIA or Via, which here should operate with VTC or bus licenses regardless of whether they were dedicated to satisfying an unmet need. And within Spain cities end up regulating in different ways, being for example Barcelona's regulation more restrictive in several services than Madrid's. Therefore, in situations where providing the service is not possible, other business alternatives could be pursued, such as licensing the technology or leasing the designed purposed vehicles (less expensive to operate than buses and more attractive to users), as suggested previously.

Main RQ: How could car manufacturers establish a profitable business in the mobility services sector?

Focusing on opportunities for automotive OEMs, the first is to sell vehicles designed for sharing services. This thesis studied the requirements of users for using shared ride-hailing services, and the most important related to the vehicle are: cleanliness and having space for luggage, and also partly related, security. As a result, vehicles that are difficult to dirty and easy to clean are required, with space for users to leave their luggage close to them safely, and with appropriate elements to ensure passenger security (e.g. emergency button or security cameras). And from operators' perspective, a key factor is to reduce maintenance costs, and this requires vehicles with more resistant and durable materials, and higher autonomy for electrical vehicles (i.e. high battery capacity).

In addition, considering the high investment capacity of vehicle manufacturers compared to new start-ups, they also have the opportunity to launch and be providers of mobility services, businesses that require large fleets to provide the availability that meets users' needs. However, at the moment is hard to earn money as providers of these types of services, and therefore, partnerships and the widening of uses are essential.

Another strength of automobile manufacturers lies in the commercial capillarity they already have as well as the customer base. For instance, this gives them the opportunity to start selling personalised mobility services to these customers as a complement to the vehicle they already have, or as a replacement when it is old. Furthermore, auto dealerships could take care of fleet maintenance operations, both of their own fleet and that of competitors, to optimise the already existing infrastructure.

Finally, a further business opportunity to be considered is to launch a MaaS that goes beyond the big city in areas where the company has a strong presence (Spain in the case of SEAT), since to do so, agreements and partnerships are again key, and considering that in each city and country the players are different, it might be difficult to have a competitive MaaS in other locations. However, it would be very interesting to have agreements with other MaaS providers, where one does not have its own, to provide roaming to users.

It is important to also discuss the limitations of this dissertation that we are aware of, as well as the future avenues of research that these may open up.

First, the use of the case study methodology complicates the generalisation of the results and their extrapolation to other cities and countries. Part of the research has focused on two cities: Barcelona and Hanover, which as most European cities have well-established public transport. Therefore, the obtained results cannot be extrapolated to cities or villages with poor public transport.

Second, under the hypothesis that in the near future, with the autonomous car, carsharing would be equivalent to ride-hailing and ridesharing to shared ride-hailing, two case studies were based on this last type of service. Also, this part of the research was only approached from the viewpoint of the users of these services.

And, as these were service tests, the pricing requirement could not be studied in detail (in Barcelona the service was free and in Hanover the price was much lower than other means of transport, since, as already stated, it was limited by the German regulatory framework). Moreover, this could have led the testers to use the service in some use cases where, by paying a commercial price, they would have not done so, or at least not as frequently.

The last limitation to be highlighted is that the feasibility of combining different uses and providing aggregated mobility services could only be studied theoretically.

Therefore, future lines of research could focus on cities and countries beyond Europe, not only to find out the potential market of car-related shared mobility services in these areas (i.e. uses and customer profiles), but also to identify the influence of socio-cultural and local differences (including local climate and accessibility to public transport) on the people's intention to use these services and how the authorities regulate them. Also, to define the most suitable areas to implement these services, including the surrounding of the cities, next studies should analyse other types of cities (e.g. different in size and in number of inhabitants and locations with rudimentary public transport) as well as their legislative barriers.

In addition, further studies could explore, both from the perspective of users and operators, how the importance of distinct design factors varies according to the type of mobility service, capturing their sensitivity to the different use cases and service characteristics. Likewise, to verify the most appropriate use cases for these services, users that pay a commercial price to use them should be interviewed.

To conclude, a last line of research is suggested in relation to the study of the feasibility of providing aggregated mobility services with uses that go beyond being a private transport service for individual passengers. It would be appropiate to analyse in detail the viability, also the advantages and disadvantages of these types of business models (which in this thesis have been studied at a theoretical level), as well as to explore the best combination of uses to ensure sufficient demand for the services throughout the day.

PUBLICATIONS AND CONFERENCES

This section provides the list of academic papers published as a result of this doctoral research, and also the list of the conferences and congresses in which we have participated.

Publications

- Gilibert, M., Ribas, I., Maslekar, N., Rosen, C., & Siebeneich, A. (2019). Mapping of service deployment use cases and user requirements for an on-demand shared ride-hailing service: MOIA test service case study. *Case Studies on Transport Policy, 7*(3), 598–606. https://doi.org/10.1016/j.cstp.2019.07.004

- Gilibert, M., & Ribas, I. (2019). Synergies between app-based car-related Shared Mobility Services for the development of more profitable business models. Accepted to be published in *Journal of Industrial Engineering and Management*.

- Gilibert, M., Ribas, I., Rosen, C., & Siebeneich, A. (2019). On-demand Shared Ride-hailing for Commuting Purposes: Comparison of Barcelona and Hanover Case Studies. Accepted to be published in *Transportation Research Procedia*. Presented at the 22nd Euro Working Group on Transportation - EWGT 2019, Barcelona.

- Gilibert, M., & Ribas, I. (2019). Main design factors for shared ride-hailing services from a user perspective. *International Journal of Transport Development and Integration, 3*(3), 195–206. https://doi.org/10.2495/TDI-V3-N3-195-206

- Gilibert, M., Ribas, I., & Rodriguez-Donaire, S. (2019). Study of commuting on-demand shared ride-hailing services: Results from a case study in Barcelona. *WIT Transactions on The Built Environment, 182*. https://doi.org/10.2495/UT180121. Presented at the 24th International Conference on Urban Transport and the Environment - Urban Transport 2018, Seville.

- Gilibert, Mireia, Ribas, I., & Rodriguez-Donaire, S. (2017). Analysis of mobility patterns and intended use of shared mobility services in the Barcelona region. Presented at the 45th European Transport Conference - ETC 2017, Barcelona. Retrieved from https://aetransport.org/en-gb/past-etc-papers/conference-papers-2017?state=b&abstractId=5734

Conferences and congresses

Participation with presentation

- 22nd Euro Working Group on Transportation - EWGT 2019 (Barcelona, 18-20 September 2019)
- 24th International Conference on Urban Transport and the Environment - Urban Transport 2018 (Seville, 19-21 September 2018)
- 4 Years from Now - 4YFN 2018 (Barcelona, 26-28 February 2018)
- 45th European Transport Conference - ETC 2017 (Barcelona, 4-6 October 2017)

Participation with poster

- Symposium On Urban Mobility Challenges 2017 (Barcelona, 13 November 2017)

Attendance

- Micromobility Europe (Berlin, 1 October 2019)
- 9th International Conference on Logistics, Informatics and Service Sciences - LISS 2019 (Maryland, 27-28 July 2019)
- X Jornades sobre ITS a Catalunya (Barcelona, 5 March 2019)
- Mobile World Congress 2019 & 4YFN 2019 (Barcelona, 25-28 February 2019)
- Smart City Expo World Congress (Barcelona, 13-15 November 2018)
- VI Conferencia Española de Car-Sharing (Barcelona, 31 October 2018)
- 8th International Conference on Logistics, Informatics and Service Sciences - LISS 2018 (Toronto, 4-5 August 2018)
- Mobile World Congress 2018 (Barcelona, 26 February - 1 March 2018)
- Smart City Expo World Congress 2017 (Barcelona, 14-16 November 2017)
- TU-Automotive Europe 2017 (Munich, 6-7 November 2017)
- Jornada Movilidad Digital y Coche Conectado (Barcelona, 27 September 2017)
- Mobile World Congress 2017 (Barcelona, 27 February - 2 March 2017)
- VIII ITS Catalunya (Barcelona, 2 February 2017)
- Smart City Expo World Congress 2016 (Barcelona, 15-17 November 2016)
- Symposium On Urban Mobility Challenges 2016 (Barcelona, 14 November 2016)

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APPENDIX A. QUESTIONNAIRE CASE STUDY I

The case study 1 questionnaire is provided below, in the language in which it was presented to interviewees (Spanish), and is also translated into English.

Block 1: Classification questions

B1-1. Eres...
You are...
1. Hombre
   Man
2. Mujer
   Woman

(50% gender quota)

B1-2. Tienes...
You are...
1. Menos de 18 años
   Under 18 years
   → End of interview
2. 18 a 29 años
   18 to 29
3. 30 a 45 años
   30 to 45
4. Más de 45 años
   Older than 45

(33% age quota)

B1-3. ¿Cuál es el origen habitual de los desplazamientos que realizas en un día laboral normal?
What is the usual origin of the trips you make on a normal working day?
1. Barcelona
   Barcelona
2. Municipios cercanos a Barcelona
   Nearby municipalities to Barcelona
3. Región Metropolitana de Barcelona
   Metropolitan Region of Barcelona
4. Otro origen
   Other origin

(50% inhabitants of Barcelona and 50% daily travellers to Barcelona

B1-4. ¿Cuál es el destino habitual de los desplazamientos que realizas en un día laboral normal?
What is the usual destination of the trips you make on a normal working day?
1. Barcelona
   Barcelona
2. Municipios cercanos a Barcelona
   Nearby municipalities to Barcelona
3. Región Metropolitana de Barcelona
   Metropolitan Region of Barcelona
4. Otro origen
   Other origin

(50% inhabitants of Barcelona and 50% daily travellers to Barcelona)

B1-5. ¿Dispones de carnet de conducir?
Do you have a driving license?

1. Sí
   Yes
2. No
   No

B1-6. ¿Dispones de coche propio?
Do you have a car?

1. Sí
   Yes
2. No
   No

B1-7. ¿Cuál es tu situación laboral?
Which is your work situation?

1. Trabajo actualmente
   Employed
2. Parado/a
   Unemployed
3. Jubilado/a
   Retired
4. Estudiante (no trabajo)
   Student (exclusively)
5. Estudiante y trabajador
   Student (also working)
6. Prefiero no contestar
   I prefer not to answer

B1-8. ¿Podrías indicar cuál es tu nivel de ingresos?
Which are your monthly incomes?

1. Hasta 700€ mensuales
   Up to 700€
2. De 701€ a 1,200€ mensuales
   701€ to 1,200€
3. De 1,201€ a 2,000€ mensuales
   1,200€ to 2,000€
4. Más de 2,000€ mensuales
   More than 2,000€
5. No tengo ingresos propios
   Without monthly incomes
6. Prefiero no contestar
   I prefer not to answer

Block 2: Usual means of transport and motivation

B2-1. ¿Podrías señalar los medios de transporte que usas habitualmente para desplazarte en un día laboral normal?
Which means of transport do you use to travel in a normal working day? (multiple choice question)

- Autobús
  Bus
- Metro
  Underground
- Tren FGC
  Train FGC
- Tren RENFE
  Train RENFE
- Tranvía
  Tram
- Coche
  Car
- Moto
  Motorbike
- Bicicleta o Bicing
  Bike / Bike Sharing
- Taxi
  Taxi

–if at least one public transport mode is chosen, skip B2-2–

B2-2. ¿Por qué motivos no utilizas ningún medio de transporte público?
Why do you not use any public transport means? (open answer)

B2-3. ¿Por qué motivos utilizas cada uno de estos medios de transporte para desplazarte en un día laboral?

"For which reasons do you use each of these means of transport to travel on a working day?" (multiple choice question, only showing the means chosen in B2-1)

	Autobús *Bus*	Metro *Underground*	Tren *Train*	Tranvía *Tram*	Taxi *Taxi*	Coche *Car*	Moto *Motorbike*	Bicicleta *Bike*
Porque es rápido *It is fast*								
Porque es cómodo *It is comfortable*								
Porque puedo aparcar cerca de mi destino *I can park near my destination*								
Porque me ayuda a desconectar *To unwind from the daily routine*								
Porque es más sostenible *It is more sustainable*								
Porque es más económico *It is cheaper*								
Porque es puntual *It is punctual*								
Porque la parada está cerca del origen/destino del trayecto *The stop is close to origin/destination*								
Porque me facilita llevar equipaje *It facilitates luggage carrying*								
Porque me permite modificar mi ruta fácilmente *It enables me to easily modify my route*								
Porque es un medio de transporte seguro *It is a safe transport mode*								
Porque no me gustan las aglomeraciones *I do not like crowds*								
Porque evito el tráfico diario *To avoid commuter traffic*								
Porque me facilita una conexión directa (sin trasbordos) con mi destino *It provides a direct connection to my destination*								

Block 3: Intention of use of shared mobility services

B3-1. ¿Cuáles de los siguientes servicios para compartir vehículo (coche, moto o bici) o trayecto has utilizado en alguna ocasión?
Which of the following services to share a vehicle (car, motorcycle, or bike) or share a trip have you ever used?
(multiple choice question)

- BlaBlaCar
- SocialCar
- Avancar
- Bicing
- Yugo
- eCooltra
- Motit
- Otros: (especificar____)
  Others: (specify)
- Ninguno de ellos
  None of them

–Brief introduction and example of the ridesharing service–

B3-2. ¿Cuál de las siguientes opciones utilizarías para trayectos de larga distancia (+150 km)?
Which of the following options would you use for long distance trips (i.e. more than 150 km)?

1. Transporte público – AVE, a un coste de 30€
   High speed train (30€)
2. Transporte público – Tren Regional, a un coste de 21€
   Regional train (21€)
3. Coche como conductor, a un coste total de 28€ (incluyendo la gasolina y el desgaste del coche)
   Private car as a driver, including the fuel and car wear (28€)
4. Trayecto compartido a través del Servicio de Compartir trayecto a un coste de 11€ el trayecto de 150 km
   Ridesharing (11€)

B3-3. En un servicio como el que se acaba de mostrar, ¿hasta qué punto considerarías importante que puedas relacionarte o conocer sobre el perfil de otros pasajeros o del conductor?
In a service such as the one just shown, to what extent would you consider it important to be able to learn about the profile of other passengers or the driver, or interact with them?

1. Muy importante
   Very important
2. Bastante importante
   Fairly important
3. Algo importante
   Important
4. Poco importante
   Slightly important
5. Nada importante
   Not at all important

–Brief introduction and example of the P2P carsharing service–

B3-4. Los coches suelen estar aparcados el 90% del tiempo, durante este tiempo:
Cars are usually parked 90% of the time, during this time:

1. Lo pondría a disposición de otros conductores a través de una plataforma de P2P carsharing, ya que tendría unos ingresos extra de unos 30€ al día
   I would make it available to other drivers through the P2P carsharing platform, as I would have an extra income of about 30€ per day
2. No lo pondría en una plataforma de P2P carsharing, ya que no me fío del uso que otras personas hagan de mi vehículo
   I would not place it on a P2P carsharing platform, since I do not trust other people to use my vehicle

–Brief introduction and example of the B2C carsharing service–

B3-5. En el caso de no disponer de coche, ¿cuál de las siguientes opciones te parecen más adecuadas para un trayecto de un día en el que haces una escapada de la ciudad y vuelves el mismo día a la ciudad (100 km ida y vuelta)?
In case of not disposing of a car, which of the following options would you find more appropriate for a one-day out of city trip (i.e. 100 km round-trip)?

1. Utilizar la red actual de transporte públicos (FGC, Metro, Autobús interurbano, RENFE)
   Use the existing public transport network (FGC, Metro, Interurban bus, RENFE)
2. Utilizar un taxi, con un coste de unos 130€ para ir al destino y volver (100km)
   Use a taxi, with a cost of about 130€, to go to the destination and return (100km)
3. Utilizar el servicio de carsharing, por un coste de 2,5€/hora (incluyendo gasolina). Serían unos 25€ por utilizarlo 10 horas
   Use the carsharing service at a cost of 2.5€/hour (including fuel). It would be about 25€ to use it for 10 hours
4. Utilizar el servicio de P2P carsharing, por un coste de unos 38€ (incluyendo alquiler de 30€ por un día y gasolina)
   Use the P2P carsharing, at a cost of about 38€ (including fuel at a cost of 30€ for a day and fuel)
5. Trayecto compartido a través del servicio de ridesharing, a un coste de 20€ para ir al destino y volver (100 km)
   Shared trip through the ridesharing service, at a cost of 20€ round-trip (100 km)

B3-6. ¿Qué tipo de forma de pago preferirías para este servicio?
What payment method would you prefer for this service?

1. Pagar por el tiempo que uso el coche (minutos)
   Pay for the time I use the car (minutes)
2. Pagar por la distancia (km) recorrida
   Pay for the distance (km) travelled
3. Pagar previamente un abono por una determinada cantidad de minutos o quilómetros (a un precio más económico)
   Pre-paid subscription for a certain number of minutes or kilometres (at a cheaper price)
4. Pagar una tarifa plana mensual por un número ilimitado de viajes
   Pay a flat monthly rate for an unlimited number of trips

B3-7. ¿Cuáles de las siguientes opciones preferirías para este servicio?
Which of the following options would you prefer for this service?

1. Sólo lo utilizaría si pudiera coger el coche cerca de casa y devolverlo cerca de mi destino
   I would only use it if the car was close to home and I could return it close to my destination
2. Sólo lo utilizaría si pudiera devolver el coche en el mismo sitio en el que lo he cogido
   I would only use it if I could return the car in the same place where I took it
3. Cualquiera de las dos opciones anteriores
   Either of the two options above

–Brief introduction and example of the singular and shared ride-hailing service–

B3-8. En el caso de no disponer de coche, y teniendo en cuenta que el punto de origen y destino no tienen una buena comunicación con metro o autobús, ¿cuál de las siguientes opciones de transporte utilizarías para un trayecto de 10 km dentro de la ciudad?
In the case of not having a car, and taking into account that the point of origin and destination do not have a good connection with metro or bus, which of the following transport options would you use for a 10 km trip within the city?

1. Utilizar un taxi, con un coste de unos 15€
   Use a taxi, at a cost of about 15€
2. Utilizar el servicio de singular ride-hailing, por un coste ligeramente inferior al taxi (sobre unos 13€)
   Use the service of singular ride-hailing, for a cost slightly lower than the taxi (about 13€)
3. Utilizar el servicio de shared ride-hailing, por un coste de entre 4€-6€, sin límite de kilómetros en un trayecto
   Use the shared ride-hailing service, for a cost of between 4€-6€, without limit of kilometres in a journey
4. Utilizar el servicio de carsharing, por un coste de 2,5€/hora (incluyendo el coste de la gasolina)
   Use the carsharing service, for a cost of 2.5€/hour (including the cost of gasoline)

B3-9. ¿Cuál de las siguientes opciones preferirías para desplazarte al aeropuerto desde un barrio periférico de Barcelona (p.ej. Sant Andreu)?
Which of the following options would you prefer to travel to the airport from a suburb of Barcelona (e.g. Sant Andreu)?

1. Utilizar un taxi, con un coste de unos 40€
   Use a taxi, at a cost of about 40€
2. Utilizar las líneas de autobús, metro y tren disponibles
   Use the available bus, underground, and train lines
3. Utilizar el Aerobús desde Plaça Catalunya (5,90€)
   Use the Aerobús service from Plaça Catalunya (5.90€)
4. Utilizar el servicio de shared ride-hailing, por un coste de 5,90€
   Use the shared ride-hailing service, at a cost of 5.90€
5. Utilizar el servicio de carsharing, por un coste de 5,5€ (0,19€/min), pudiendo devolver el coche en el aeropuerto
   Use the carsharing service, for a cost of 5.5€ (0.19€/min), being able to return the car at the airport

B3-10. ¿Qué tipo de forma de pago preferirías para estos servicios de ride-hailing?
What type of payment method would you prefer for these private taxi and shared private taxi services?

1. Pagar por la distancia (km) recorrida
   Pay for the distance (km) travelled
2. Pagar un precio determinado por zona (como el autobús o el tren)
   Pay a certain price per area (such as the bus or train)
3. Pagar previamente un abono por una determinada cantidad de minutos o quilómetros (a un precio más económico)
   Pay a pass in advance for a certain number of minutes or kilometres (at a cheaper price)
4. Pagar una tarifa plana mensual por un número ilimitado de viajes
   Pay a flat monthly rate for an unlimited number of trips

B3-11. ¿Qué distancia (en tiempo) estarías dispuesto/a a caminar desde tu origen hasta que el servicio de singular o shared ride-hailing te recogiera, o desde que te deja hasta tu destino?
What distance (in time) would you be willing to walk from your origin until the service of singular or shared ride-hailing picks you up, or since it drops you off to your destination?

1. No recorrería ninguna distancia, prefiero que me recoja y me deje donde le indique.
   I would not walk any distance, I prefer that the service picks me up and drops me off where I indicate.
2. Estaría dispuesto/a a recorrer hasta 3 minutos andando.
   I would be willing to walk up to 3 minutes.
3. Estaría dispuesto a recorrer hasta 6 minutos andando.
   I would be willing to walk up to 6 minutes.
4. Estaría dispuesto a recorrer hasta 10 minutos andando.
   I would be willing to walk up to 10 minutes.

B3-12. Si estos servicios estuviesen disponibles tal y como se muestra en las descripciones que acabas de leer, ¿hasta qué punto estarías dispuesto/a a utilizarlos? Por favor, utiliza una escala de 1 a 7 donde 1 significa “seguro que no lo utilizaría” y 7 “seguro que lo utilizaría”. Puedes dar puntuaciones intermedias para matizar tu opinión.
If these services were available as shown in the descriptions you have just read, to what extent would you be willing to use them? Please, use a scale of 1 to 7, where 1 means "sure I would not use it" and 7 means "sure I would use it". You can give intermediate scores to qualify your opinion.

	Seguro que no lo utilizaría *Sure I would not use it*						Seguro que lo utilizaría *Sure I would use it*
Servicio de ridesharing *Ridesharing service*	1	2	3	4	5	6	7
Servicio de P2P carsharing *P2P carsharing service*	1	2	3	4	5	6	7
Servicio de B2C carsharing *B2C carsharing service*	1	2	3	4	5	6	7
Servicio de singular ride-hailing *Singular ride-hailing service*	1	2	3	4	5	6	7
Servicio de shared ride-hailing *Shared ride-hailing service*	1	2	3	4	5	6	7

APPENDIX B. QUESTIONNAIRE CASE STUDY II

The case study 2 questionnaire is provided below, in the language in which it was presented to interviewees (Catalan), and is also translated into English.

Block 1: Classification questions

B1-1. Gènere
Gender
1. Home
   Man
2. Dona
   Woman

B1-2. Edat
Age
1. 18 a 29 anys
   18 to 29
2. 30 a 45 anys
   30 to 45
5. Més de 45 anys
   Older than 45

B1-3. Disposes de carnet de conduir?
Do you have a driving license?
1. Sí
   Yes
2. No
   No

B1-4. Disposes de cotxe (propi o que estigui a la teva disposició durant la setmana)?
Do you have a car (of your own or at your disposal during the week)?
1. Sí
   Yes
2. No
   No

B1-5. Disposes de moto (pròpia o que estigui a la teva disposició durant la setmana)?
Do you have a motorbike (of your own or at your disposal during the week)?
1. Sí
   Yes
2. No
   No

B1-6. Com fas el trajecte de l'Eixample fins al lloc de treball / universitat i viceversa, habitualment?
How do you travel from l'Eixample to your job or university and vice versa, regularly?
1. Utilitzo un únic mitjà de transport
   I use a single means of transport
2. Utilitzo varis mitjans de transport
   I use several means of transport

B1-7. Quin/s mitjans de transport utilitzes?
Which means of transport do you use to travel in a normal working day? (multiple choice question if B1-6 answer is 2)

- Autobús
  Bus
- Metro
  Underground
- Mitjans ferroviaris (FGC, RENFE, tramvia)
  Rail transport (FGC, RENFE, tram)
- Cotxe propi
  Own car
- Moto propia
  Own motorbike
- Taxi
  Taxi
- Altres: (definir)
  Others: (define)

Block 2: Perception of the service

Valora en una escala del 1 al 7, sent 1 "totalment en desacord" i 7 "totalment d'acord" les següent qüestions:

Totalment en desacord *Totally disagree*	Molt en desacord *Strongly disagree*	En desacord *Disagree*	Ni acord ni en desacord *Neither agree or disagree*	D'acord *Agree*	Molt d'acord *Strongly agree*	Totalment d'acord *Totally agree*
1	2	3	4	5	6	7

B2-1. Preu del servei
Price of the service

	1	2	3	4	5	6	7
Estic disposat/ada a pagar 3,5€ per un trajecte del servei de shuttle com el provat aquests dies. *I would pay 3.5€ per trip for a shuttle service trip as the tested these days.*							
Estic disposat/ada a pagar 4,5€ per un trajecte del servei de shuttle com el provat aquests dies. *I would pay 4.5€ per trip for a shuttle service trip as the tested these days.*							
En cas de disposar d'una targeta de fidelització faria més ús del servei de shuttle (per exemple, tenir descomptes per la utilització repetitiva del servei o gratuïtat d'1 trajecte per cada 10). *In case I had a loyalty card, I would use more the shuttle service (e.g. having discounts for repetitive use of the service or one free trip after 10).*							
En cas de poder pagar amb el mateix sistema que el metro o l'autobús de Barcelona, faria més ús d'aquest servei de shuttle (per exemple, amb la futura T-Mobilitat). *In case I could pay with the same system of the train, metro or bus, I would use more the shuttle service.*							
Li dono molta importància al preu a l'hora de fer-me usuari habitual d'un servei com el shuttle on demand. *I give high importance to the price to become a frequent user of an on-demand shuttle service.*							

B2-2. La proximitat d'accés

Proximity to the pick-up point

	1	2	3	4	5	6	7
La distància fins a la parada o punt de recollida pactat amb el servei de shuttle on demand ha estat més curta en comparació amb el bus urbà de Barcelona. *The distance to the pick-up point was shorter compared to the regular bus.*							
La distància fins al punt de recollida indicat pel servei de shuttle on demand ha estat més curta en comparació amb el servei de taxi de Barcelona. *The distance to the pick-up point was shorter compared to the taxi service.*							
Estic disposat/ada a caminar 5min des del punt on sol·licito el servei de shuttle (lloc de sortida – punt "A") fins al punt de recollida. *I am willing to walk 5min from where I request the shuttle service (starting - point "A") to the pick-up point.*							
Estic disposat/ada a caminar 10min des del punt on sol·licito el servei de shuttle (lloc de sortida – punt "A") fins al punt de recollida. *I am willing to walk 10min from where I request the shuttle service (starting - point "A") to the pick-up point.*							
Estic disposat/ada a pagar una mica més pel servei de shuttle a canvi de menys distància a la parada inicial i final. *I am willing to pay a little more for the shuttle service in return for less distance to the pick-up and drop-off points.*							
En cas de pluja o molta calor, estic disposat/ada a caminar 5min des del punt on sol·licito el servei de shuttle (lloc de sortida – punt "A") fins al punt de recollida. *In case of rain or heat, I am willing to walk 5min from where I request the shuttle service to the pick-up point.*							
En cas de pluja o molta calor, estic disposat/ada a caminar 10min des del punt on sol·licito el servei de shuttle (lloc de sortida – punt "A") fins al punt de recollida. *In case of rain or heat, I am willing to walk 10min from where I request the shuttle service to the pick-up point.*							

B2-3. El curt temps d'espera

Short waiting times

	1	2	3	4	5	6	7
El temps d'espera que se t'ha comunicat a l'hora de demanar el servei de shuttle ha estat més curt en comparació amb el bus urbà de Barcelona. *The waiting time notified when requesting the shuttle service was shorter compared to the usual waiting time of the Barcelona bus service.*							
El temps d'espera que se t'ha comunicat a l'hora de demanar el servei de shuttle ha estat més curt en comparació amb el servei de taxi de Barcelona. *The waiting time notified when requesting the shuttle service was shorter compared to the waiting time of the Barcelona taxi service.*							
Estic disposat/ada a esperar 10min per a que el shuttle em reculli (temps des de la petició via app fins a l'arribada del shuttle). *I am willing to wait 10 minutes for the shuttle to pick me up (time between the request via the app and the arrival of the shuttle).*							
Estic disposat/ada a pagar una mica més pel servei de shuttle a canvi d'un menor temps d'espera. *I am willing to pay a little more for the shuttle service in exchange for a shorter waiting time.*							

B2-4. La puntualitat en l'arribada del shuttle

Punctuality of the shuttle

	1	2	3	4	5	6	7
L'arribada del servei de shuttle ha estat més puntual en comparació amb el bus urbà de Barcelona. *The arrival of the shuttle service was more punctual compared to the Barcelona bus service.*							
L'arribada del servei de shuttle ha estat més puntual en comparació amb el servei de taxi de Barcelona. *The arrival of the shuttle service was more punctual compared to the Barcelona taxi service.*							
Estic disposat/ada a acceptar un retard en l'arribada del shuttle (arriba més tard del que t'ha indicat la app en el moment de reservar el viatge) tenint en compte que arribaré al destí a l'hora indicada. *I am willing to accept a delay in the arrival of the shuttle (it arrives later than the time the app notified you during the request) considering that I will arrive at my destination at the scheduled time.*							
**L'arribada del servei de shuttle ha estat menys puntual en comparació amb el servei de taxi de Barcelona.* ** The arrival of the shuttle service was less punctual compared to the Barcelona taxi service.*							
Estic disposat/ada a acceptar un retard en l'arribada del shuttle (arriba més tard del que t'ha indicat la app en el moment de reservar el viatge) tenint en compte que això comportarà que arribi amb un lleuger retard al meu destí. *I am willing to accept a delay in the arrival of the shuttle (it arrives later than the time the app notified you during the request) considering that this will cause a slight delay in reaching my destination.*							
Estic disposat/ada a agafar aquest servei de shuttle si el temps d'espera addicional (retard) al punt de recolllida pactat és d'entre 5 i 10 minuts. *I am willing to accept a delay in the arrival of the shuttle if the additional waiting time (delay) to the agreed pick-up point is between 5 and 10 minutes.*							
Estic disposat/ada a agafar aquest servei de shuttle si el temps d'espera addicional (retard) al punt de recolllida pactat és d'entre 5 i 10 minuts si m'ofereixen una compensació econòmica per l'import del viatge (4€). *I am willing to accept a delay of 5-10 minutes in the arrival of the shuttle if I am offered a compensation for the cost of the trip (4€).*							

B2-5. La rapidesa del trajecte

Speed of the trip

	1	2	3	4	5	6	7
El temps de trajecte del servei del shuttle, un cop a dins del vehicle, ha estat més ràpid en comparació amb el bus urbà de Barcelona. *The travel time of the shuttle service, once inside the vehicle, was faster compared to the Barcelona bus service.*							
El temps de trajecte del servei del shuttle, un cop a dins del vehicle, ha estat més ràpid en comparació amb el taxi de Barcelona. *The travel time of the shuttle service, once inside the vehicle, was faster compared to the Barcelona taxi service.*							
Estic disposat/ada a pagar una mica més pel servei de shuttle a canvi d'un servei més ràpid. *I am willing to pay a little more for the shuttle service in exchange for a faster service.*							
Li dono molta importància a la rapidesa a l'hora de fer-me usuari habitual d'un servei com el shuttle on demand. *I give high importance to the speed to become a frequent user of an on-demand shuttle service.*							

B2-6. El fet de compartir el trajecte

The fact of sharing the trip

	1	2	3	4	5	6	7
M'agrada més compartir trajecte amb menys persones que amb el bus urbà de Barcelona. *I like more sharing the ride with fewer people than with the Barcelona bus service.*							
Estic disposat/ada a pagar una mica més pel servei de shuttle a canvi de compartir amb menys persones el trajecte. *I am willing to pay a little more for the shuttle service in exchange for sharing the ride with fewer people.*							
Li dono molta importància al fet de compartir amb poques persones el trajecte, a l'hora de fer-me usuari habitual d'un servei com el shuttle on demand. *I give high importance to the fact of sharing the trip with fewer people to become a frequent user of an on-demand shuttle service.*							

B2-7. El confort del servei

Comfort of the trip

	1	2	3	4	5	6	7
M'agrada més la comoditat del vehicle ofert pel servei de shuttle que l'oferta pel bus urbà de Barcelona. *I like more the comfort of the vehicle of the shuttle service than the comfort of the Barcelona bus service.*							
M'agrada més la comoditat del vehicle ofert pel servei de shuttle que l'oferta pel taxi de Barcelona. *I like more the comfort of the vehicle of the shuttle service than the comfort of the Barcelona taxi service.*							
Li dono molta importància a la comoditat del vehicle ofert pel servei de shuttle, a l'hora de fer-me usuari habitual d'un servei com el shuttle on demand. *I give high importance to the comfort of the vehicle to become a frequent user of an on-demand shuttle service.*							
Li dono molta importància a la comoditat de no haver de fer transbordaments, a l'hora de fer-me usuari habitual d'un servei com el shuttle on demand. *I give high importance to the convenience of not having to transfer to become a frequent user of an on-demand shuttle service.*							

B2-8. La puntualitat en l'arribada a destí

Punctuality of arriving at the destination

	1	2	3	4	5	6	7
Estic disposat/ada a agafar aquest servei de shuttle si arribo a la meva destinació amb un retard de menys de 5 minuts. *I am willing to take the shuttle service if I reach my destination with a delay of less than 5 minutes.*							
Estic disposat/ada a agafar aquest servei de shuttle si arribo a la meva destinació amb un retard d'entre 5 i 10 minuts. *I am willing to take the shuttle service if I reach my destination with a delay of 5-10 minutes.*							
**No estic disposat/ada a agafar aquest servei de shuttle si arribo a la meva destinació amb un retard d'entre 5 i 10 minuts.* **I am not willing to take the shuttle service if I reach my destination with a delay of 5-10 minutes.*							
Estic disposat/ada a agafar aquest servei de shuttle si rebo una compensació econòmica per l'import del viatge (4€), en cas d'arribar a la meva destinació amb un retard d'entre 5 i 10 minuts. *I am willing to take the shuttle service if I receive an economic compensation for the cost of the trip (4€) and I reach my destination with a delay of between 5 and 10 minutes.*							
Estic disposat/ada a agafar aquest servei de shuttle si rebo una compensació econòmica per l'import del viatge (4€), en cas d'arribar a la meva destinació amb un retard superior als 10 minuts. *I am willing to take the shuttle service if I receive an economic compensation for the cost of the trip (4€) and I reach my destination with a delay of more than 10 minutes.*							

Block 3: Evaluation of service factors and use cases

B3-1. Quina importància tindrien per tu els següents aspectes, a l'hora de fer-te usuari habitual d'un futur servei de shuttle a la demanda?
How important would the following aspects be for you to become a frequent user of an on-demand shuttle service?

	Gens important *Not at all important*	Poc important *Low importance*	Lleuge-rament important *Slightly important*	Neutral *Neutral*	Moder-adament important *Moderately important*	Molt important *Very important*	Extrama-dament important *Extremely important*
Els serveis addicionals (WiFi, revistes, etc.) *Additional services (WiFi, magazines, etc.)*	1	2	3	4	5	6	7
La neteja *Cleanliness*	1	2	3	4	5	6	7
La privacitat *Privacy*	1	2	3	4	5	6	7
L'estètica del vehicle *Aesthetic*	1	2	3	4	5	6	7
Que el vehicle fos elèctric *Vehicle was electric*	1	2	3	4	5	6	7
La marca del vehicle *Brand of the vehicle*	1	2	3	4	5	6	7
La integració del servei amb altres serveis de mobilitat *Integration with other transport services*	1	2	3	4	5	6	7
La reputació del proveïdor del servei *Reputation of the service provider*	1	2	3	4	5	6	7
La seguretat *Safety*	1	2	3	4	5	6	7
La fiabilitat *Reliability*	1	2	3	4	5	6	7
La disponibilitat *Availability*	1	2	3	4	5	6	7

B3-2. En quins casos utilitzaries en el futur un servei de shuttle a la demanda?
In which cases would you use an on-demand shuttle service in the future? *(multiple choice question)*

1. Per anar a treballar / a la universitat (i/o tornar)
   To commute (work / university)
2. Per a desplaçaments de feina
   For business trips
3. Per anar de compres quotidianes (compra setmanal)
   To go shopping for groceries
4. Per anar de compres no quotidianes (ex: roba, tecnologia)
   Other shopping (e.g. clothes, technology)
5. Per anar al metge / hospital
   To go to medical visits
6. Per acompanyar / anar a buscar una altra persona (ex: fills al col·legi)
   Accompanying / picking up another person (e.g. children at school)
7. Per a desplaçaments d'oci (cinemes, restaurants, activitats culturals o d'esport)
   For leisure trips (cinema, restaurant, culture activities or sports)
8. Altres: (especificar)
   Others: (specify)

APPENDIX C. QUESTIONNAIRE CASE STUDY III

The case study 3 questionnaire is provided below, in the language in which it was presented to interviewees (German), and is also translated into English.

Block 1: Classification questions

B1-1. Geschlecht
Gender
1. Männlich
   Man
2. Weiblich
   Woman

B1-2. Alter
Age
1. Unter 18 Jahre
   Under 18 years
2. 18 bis 29 Jahre
   18 to 29
3. 30 bis 45 Jahre
   30 to 45
4. 46 bis 65 Jahre
   46 to 65
5. Über 65 Jahre
   Older than 65

B1-3. Hast du einen Führerschein?
Do you have a driving license?
1. Ja
   Yes
2. Nein
   No

B1-4. Hast du ein Auto (ein eigenes oder unter der Woche eines zur Verfügung)?
Do you have a car (of your own or at your disposal during the week)?
1. Ja
   Yes
2. Nein
   No

B1-5. Hast du ein Motorrad/einen Roller (ein eigenes oder unter der Woche eines zur Verfügung)?
Do you have motorbike (of your own or at your disposal during the week)?
1. Ja
   Yes
2. Nein
   No

Block 2: Commuting

B2-1. Wo wohnst du?
Where do you leave?
1. Hannover
   Hanover
2. Direktes Umland von Hannover
   Surrounding cities of Hanover
3. Region Hannover oder darüber hinaus
   Other towns of Hanover region or farer

B2-2. Wie ist deine Arbeitssituation?
What is your work situation?
1. Angestellt
   Employed
2. Selbstständig
   Self-employed
3. Student
   Student
4. Arbeitslos
   Unemployed
5. Rentner
   Retired

B2-3. Wo arbeitest/studierst du?
Where do you work/study?
1. Hannover
   Hanover
2. Direktes Umland von Hannover
   Surrounding cities of Hanover
3. Region Hannover oder darüber hinaus
   Other towns of Hanover region or farer

B2-4. Wie lang ist deine Pendlerstrecke? (eine Strecke)
How long is your commuter route? (one way)
1. <2 km
2. 2-5 km
3. 5-10 km
4. 10-20 km
5. >20 km

B2-5. Mit welchem Verkehrsmittel fährst du zur Arbeit / zum Studium? (mehrere Optionen möglich)
Which means of transport do you use to go to study/work? (multiple choice question)
1. Bus
   Bus
2. Stadtbahn (M1-M10)
   Light railway
3. S-Bahn (S1-S7)
   Rapid transit
4. Zug (RE/IC/ICE)
   Train
5. Auto
   Car
6. Motorrad oder Roller
   Motorbike or scooter
7. Fahrrad
   Bicycle

8. Taxi
   Taxi
9. MOIA
   Shared ride-hailing service MOIA
10. Andere: (speziziere deine Antwort)
    Other: (specify your answer)

Block 3: Personal mobility & Intention of use of shared mobility services

B3-1. Wenn du dich ALLEIN privat innerhalb der Stadt fortbewegst, welche Verkehrsmittel nutzt du normalerweise? (mehrere Optionen sind möglich)
Which means of transport do you usually use when travelling ALONE within the city for personal reasons? (multiple choice question)

1. Bus
   Bus
2. Stadtbahn (M1-M10)
   Light railway
3. S-Bahn (S1-S7)
   Rapid transit
4. Zug (RE/IC/ICE)
   Train
5. Auto
   Car
6. Motorrad oder Roller
   Motorbike or scooter
7. Fahrrad
   Bicycle
8. Taxi
   Taxi
9. MOIA
   Shared ride-hailing service MOIA
10. Andere: (speziziere deine Antwort)
    Other: (specify your answer)

B3-2. Wenn du dich bspw. mit deiner FAMILIE oder deinen FREUNDEN privat innerhalb der Stadt fortbewegst, welche Verkehrsmittel nutzt du normalerweise?
Which means of transport do you usually use when travelling WITH FAMILY OR FRIENDS within the city for personal reasons? (multiple choice question)

1. Bus
   Bus
2. Stadtbahn (M1-M10)
   Light railway
3. S-Bahn (S1-S7)
   Rapid transit
4. Zug (RE/IC/ICE)
   Train
5. Auto
   Car
6. Motorrad oder Roller
   Motorbike or scooter
7. Fahrrad
   Bicycle
8. Taxi
   Taxi
9. MOIA
   Shared ride-hailing service MOIA
10. Andere: (speziziere deine Antwort)
    Other: (specify your answer)

B3-3. Würdest du MOIA (gemeinsamer Transport mit einem professionellen Fahrer) nutzen, ...
You would you use MOIA... (multiple choice question)

1. um zu pendeln: Arbeit / Ausbildung / Schule / Universität?
   to commute: work / education / school / university?
2. um deine Kinder zur Schule oder Eltern ins Krankenhaus, etc. zu begleiten?
   to accompany your children to school or parents to the hospital, etc.?
3. für Tagesausüge?
   for a day trip?
4. für Geschäftsreisen?
   for business trip?
5. um allein einzukaufen?
   to shop alone?
6. um mit deiner Familie oder Freunden einzukaufen?
   to shop with your family or friends?
7. um allein nach dem Ausgehen nach Hause zu kommen?
   to come home alone after going out?
8. um mit deiner Familie oder Freunden auszugehen?
   to go out with your family or friends?
9. um zum bzw. vom Flughafen zu kommen?
   to get to or from the airport?
10. Andere: (speziziere deine Antwort)
    Other: (specify your answer)
11. Ich würde MOIA nie nutzen.
    I would never use MOIA.

B3-4. Würdest du Peer-to-Peer (P2P) Ridesharing (Service, der Fahrer und Passagiere verbindet, die zu einem gemeinsamen Ziel fahren, z.B. Blablacar) nutzen, um ...
You would use P2P ridesharing... (multiple choice question)

1. um zu pendeln: Arbeit / Ausbildung / Schule / Universität?
   to commute: work / education / school / university?
2. um deine Kinder zur Schule oder Eltern ins Krankenhaus, etc. zu begleiten?
   to accompany your children to school or parents to the hospital, etc.?
3. für Tagesausüge?
   for a day trip?
4. für Geschäftsreisen?
   for business trip?
5. um allein einzukaufen?
   to shop alone?
6. um mit deiner Familie oder Freunden einzukaufen?
   to shop with your family or friends?
7. um allein nach dem Ausgehen nach Hause zu kommen?
   to come home alone after going out?
8. um mit deiner Familie oder Freunden auszugehen?
   to go out with your family or friends?
9. um zum bzw. vom Flughafen zu kommen?
   to get to or from the airport?
10. Andere: (speziziere deine Antwort)
    Other: (specify your answer)
11. Ich würde P2P ridesharing nie nutzen.
    I would never use P2P ridesharing.

B3-5. Würdest du Carsharing (Mietwagen pro Minute, Stunde oder Tag, z.B. car2go, DriveNow) nutzen, um...
You would use carsharing... (multiple choice question)

1. um zu pendeln: Arbeit / Ausbildung / Schule / Universität?
   to commute: work / education / school / university?
2. um deine Kinder zur Schule oder Eltern ins Krankenhaus, etc. zu begleiten?
   to accompany your children to school or parents to the hospital, etc.?

3. für Tagesausüge?
   for a day trip?
4. für Geschäftsreisen?
   for business trip?
5. um allein einzukaufen?
   to shop alone?
6. um mit deiner Familie oder Freunden einzukaufen?
   to shop with your family or friends?
7. um allein nach dem Ausgehen nach Hause zu kommen?
   to come home alone after going out?
8. um mit deiner Familie oder Freunden auszugehen?
   to go out with your family or friends?
9. um zum bzw. vom Flughafen zu kommen?
   to get to or from the airport?
10. Andere: (speziziere deine Antwort)
    Other: (specify your answer)
11. Ich würde Carsharing nie nutzen.
    I would never use carsharing.

B3-6. Würdest du einzelnes Ride-Hailing (alternativer Service zum Taxi, z.B. Uber) nutzen...
You would use ride-hailing... (multiple choice question)

1. um zu pendeln: Arbeit / Ausbildung / Schule / Universität?
   to commute: work / education / school / university?
2. um deine Kinder zur Schule oder Eltern ins Krankenhaus, etc. zu begleiten?
   to accompany your children to school or parents to the hospital, etc.?
3. für Tagesausüge?
   for a day trip?
4. für Geschäftsreisen?
   for business trip?
5. um allein einzukaufen?
   to shop alone?
6. um mit deiner Familie oder Freunden einzukaufen?
   to shop with your family or friends?
7. um allein nach dem Ausgehen nach Hause zu kommen?
   to come home alone after going out?
8. um mit deiner Familie oder Freunden auszugehen?
   to go out with your family or friends?
9. um zum bzw. vom Flughafen zu kommen?
   to get to or from the airport?
10. Andere: (speziziere deine Antwort)
    Other: (specify your answer)
11. Ich würde ride-hailing nie nutzen.
    I would never use carsharing.

Block 4: Experience with MOIA

B4-1. Hast du den Service von MOIA schon einmal genutzt?
Have you ever used the MOIA service?

1. Ja
   Yes
2. Nein
   No
   → If the answer is no, the survey continues with block 5.

B4-2. Wie oft benutzt du den Service?
How often do you use the service?

1. Weniger als 1 Mal pro Monat
   Less than once per month
2. 1 bis 4 Mal pro Monat
   1 to 4 times per month
3. Mehr als 1 Mal pro Woche
   More than once per week
4. Fast täglich / täglich
   Almost daily / daily

B4-3. Wann benutzt du den Service?
When do you use the service? (both options are possible)

1. Unter der Woche
   During the week
2. Am Wochenende
   At weekend

B4-4. In einem täglichen Pendelszenario, würde ich MOIA öfter nutzen, wenn...
In a daily commuting scenario, I would use MOIA more often if...

	Stimme nicht zu *Strongly disagree*	Stimme eher nicht zu *Disagree*	Nicht sicher *Neutral*	Stimme eher zu *Agree*	Stimme voll zu *Strongly agree*
der Service pünktlicher wäre *the service was more punctual*	1	2	3	4	5
ich ein persönliches Display zur Unterhaltung hätte *I had a personal display for entertainment*	1	2	3	4	5
es einen Gepäckbereich geben würde (Koffer, Taschen, etc.) *there was a baggage area (suitcases, bags, etc.)*	1	2	3	4	5
ich mein Fahrrad transportieren könnte *I could transport my bicycle*	1	2	3	4	5
die Wartezeit kürzer wäre *the waiting time was shorter*	1	2	3	4	5
der Service Door-to-Door wäre (Abholung und Rückgabe so nah wie möglich an deiner Tür) *the service was door-to-door (pick-up and drop-off as close to your door as possible)*	1	2	3	4	5
es möglich wäre, im Voraus zu buchen *it was possible to book it in advance*	1	2	3	4	5
ich neben meinen Freunden / Familie / Kollegen sitzen könnte *I could sit next to my friends / family / colleagues*	1	2	3	4	5
der Service schneller wäre *the service was faster*	1	2	3	4	5
der Einzelpreis bei Reisen mit mehreren Personen niedriger wäre *the unit price was lower for trips with several persons*	1	2	3	4	5
es mit weniger Leute geteilt werden würde *it was shared with fewer people*	1	2	3	4	5
ich den genauen Sitzplatz über die App reservieren könnte *I could reserve the exact seat via the app*	1	2	3	4	5
ich das ganze Fahrzeug reservieren könnte *I could reserve the whole vehicle*	1	2	3	4	5
der Preis für eine wiederholte Benutzung niedriger wäre *the price for repeated use was lower*	1	2	3	4	5
es einfacher wäre, einen Kinderwagen zu transportieren *it was easier to transport a pram*	1	2	3	4	5
es komfortabler wäre zu arbeiten oder zu lessen (Wifi, USB-Charger, Ablageächen, Leseleuchten, etc.) *it was more comfortable to work or read (Wi-Fi, USB charger, storage compartments, reading lights, etc.)*	1	2	3	4	5

B4-5. Gibt es noch weitere Punkte, die dich dazu bringen würden, den Service in einem Pendelszenario öfter zu nutzen?
Are there any other points that would make you use the service more often in a commuting scenario? (open question)

B4-6. Bei reisen mit Familie oder Freunden, würde ich MOIA öfter nutzen, wenn...
When travelling with family or friends, I would use MOIA more often if...

	Stimme nicht zu *Strongly disagree*	Stimme eher nicht zu *Disagree*	Nicht sicher *Neutral*	Stimme eher zu *Agree*	Stimme voll zu *Strongly agree*
der Service pünktlicher wäre *the service was more punctual*	1	2	3	4	5
ich ein persönliches Display zur Unterhaltung hätte *I had a personal display for entertainment*	1	2	3	4	5
es einen Gepäckbereich geben würde (Koffer, Taschen, etc.) *there was a baggage area (suitcases, bags, etc.)*	1	2	3	4	5
ich mein Fahrrad transportieren könnte *I could transport my bicycle*	1	2	3	4	5
die Wartezeit kürzer wäre *the waiting time was shorter*	1	2	3	4	5
der Service Door-to-Door wäre (Abholung und Rückgabe so nah wie möglich an deiner Tür) *the service was door-to-door (pick-up and drop-off as close to your door as possible)*	1	2	3	4	5
es möglich wäre, im Voraus zu buchen *it was possible to book it in advance*	1	2	3	4	5
ich neben meinen Freunden / Familie / Kollegen sitzen könnte *I could sit next to my friends / family / colleagues*	1	2	3	4	5
der Service schneller wäre *the service was faster*	1	2	3	4	5
der Einzelpreis bei Reisen mit mehreren Personen niedriger wäre *the unit price was lower for trips with several persons*	1	2	3	4	5
es mit weniger Leute geteilt werden würde *it was shared with fewer people*	1	2	3	4	5
ich den genauen Sitzplatz über die App reservieren könnte *I could reserve the exact seat via the app*	1	2	3	4	5
ich das ganze Fahrzeug reservieren könnte *I could reserve the whole vehicle*	1	2	3	4	5
der Preis für eine wiederholte Benutzung niedriger wäre *the price for repeated use was lower*	1	2	3	4	5
es einfacher wäre, einen Kinderwagen zu transportieren *it was easier to transport a pram*	1	2	3	4	5
es komfortabler wäre zu arbeiten oder zu lessen (Wifi, USB-Charger, Ablageächen, Leseleuchten, etc.) *it was more comfortable to work or read (Wi-Fi, USB charger, storage compartments, reading lights, etc.)*	1	2	3	4	5

B4-7. Gibt es noch weitere Punkte, die dich dazu bringen würden, den Service in einem sozialen Szenario öfter zu nutzen?
Are there any other points that would make you use the service more often in a social scenario? (open question)

Block 5: Reasons to not use MOIA

B5-1. Warum hast du es noch nicht versucht?
Why have you still not tried it? (open question)