



# STARS

Shared mobility opportunities And  
challenges for European cities

Research and Innovation action

H2020-MG-2016-2017

# Key technology and social innovation drivers for car sharing

## Deliverable D2.2

Authors: Esti SANVICENTE (LGI), Daniele KIELMANOWICZ (LGI), Johannes RODENBACH (Autodelen),  
Andrea CHICCO (POLITO), Erika RAMOS (UGOT)

[www.stars-h2020.eu](http://www.stars-h2020.eu)



*This project has received funding from the Horizon 2020 programme under  
the grant agreement n°769513*

## Document Information

<b>Grant Agreement</b>	769513
<b>Project Title</b>	Key technology and social innovation drivers for car-sharing
<b>Project Acronym</b>	STARS
<b>Project Start Date</b>	1 October 2017
<b>Related work package</b>	WP 2 - Car sharing in European cities: actual status and trends
<b>Related task(s)</b>	Task 2.2 - Technological and social innovation drivers of mobility sharing services
<b>Lead Organisation</b>	LGI
<b>Submission date</b>	31 March 2018
<b>Dissemination Level</b>	Public

## History

Date	Submitted by	Reviewed by	Version (Notes)
18 March 2018	LGI	Johannes RODENBACH, Andrea CHICCO, Michael GLOTZ- RICHTER, Gunnar NEHRKE	V1
11 April 2018	LGI	Marco DIANA	V2

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## Acronyms

<b>AI</b>	Artificial Intelligence	<b>ML</b>	Machine learning
<b>APPS</b>	Mobile applications	<b>NAM</b>	models of norm-activation
<b>CAV</b>	Connected and autonomous Vehicles	<b>NFC</b>	Near Field Communication
<b>CFS</b>	Critical Success Factors	<b>PEU</b>	Perceived Ease of Use
<b>EVs</b>	electric vehicles	<b>PU</b>	Perceived Usefulness
<b>Eurostat</b>	Statistical office of the European Union	<b>R&amp;D</b>	Research and development
<b>EY</b>	Ernst & Young	<b>SMCI</b>	Shared Mobility City Index
<b>GPS</b>	Global positioning system	<b>SUMP</b>	Sustainable Urban Mobility Plan
<b>ICT</b>	Information and communications technology	<b>TRA</b>	Theory of reasoned action
<b>IL</b>	Intelligent logistics	<b>TBD</b>	The Theory of Planned Behaviour
<b>IoT</b>	The Internet of Things	<b>UK</b>	United Kingdom
<b>ISCED11</b>	International Standard Classification of Education	<b>UTAUT</b>	Unified Theory of Acceptance and Use of Technology
<b>KM</b>	Kilometer	<b>WP</b>	Work Package
<b>KPIs</b>	Key Performance Indicators		
<b>Maas</b>	Mobility as a Service		

## SUMMARY

Car sharing has huge potential to improve quality of life and traffic conditions in cities. It offers a car at your disposal without the need of ownership and has the potential to reduce the number of cars in cities without reducing individual mobility. The wide spread of information and communication devices (smartphones in particular) and of social media and web platforms, together with the sharing economy that is growing into a cultural consumption approach, are at the basis of this development. Moreover, smart technology has helped to improve the experience of using car sharing, making booking, accessing and using shared transport easier.

While car sharing in recent years has witnessed double-digit growth, particularly in bigger cities where the costs of owning a car can be more easily offset, only a small percentage of people actually use it when compared to other urban modes. This leaves a gap, meaning that cities are unable to reap the full benefits of car sharing.

With this in mind, the STARS partners set out to better capture the underlying forces that affect car sharing. In fact, D2.2 of the STARS project focuses on a number of aspects to understand how mobility sharing practices are influenced by the arrival of digital technologies, automotive advances, the emergence of social innovation patterns and mobility behaviour and choices.

The first chapter of the present report explores the three types of underlying forces that are essential to understanding the new era of mobility and particularly the future of car sharing. These include technology enablers, such as ICT based innovations and automotive advances; societal changes such as the emergence of new forms of sharing economy practices and Mobility as a Service; and attitudinal and motivational characteristics of citizens with regards to emerging urban transport opportunities.

The second part aims to advance understanding of how car sharing adoption trends are influenced by the evolution of sociodemographic characteristics (population characteristics, education level, income), car ownership rate and mobility split, and the use of web 2.0 services (participation in social networks, internet banking and the use of internet for travelling purposes). To do so, we undertook a complementary approach in which we analysed aggregated statistics for a time series in a given area, or the same statistics in different countries and cities. Car sharing data was gathered through different sources, including car sharing operators' websites, newspaper, annual surveys for the different car sharing systems, and statistical data at national and city level.

Finally, a specific analysis of three use cases was carried out with the objective of studying the main drivers and barriers to deploy car sharing in urban areas. Autolib in Paris, Cambio in Bremen and Drivy in Barcelona, were the selected use cases. The methodology undertaken to conduct the three case studies combined data from literature analysis and expert interviews. A multi-level perspective was then used to help analyse both the internal (business model and business performance) and external (city/local related) factors shaping the car sharing deployment in these urban areas.

The analysis showed that both digital technologies and transport innovations hold a great promise for the development of car sharing services, in terms of enhancing fleet management and maintenance and improving user's experience. Moreover, while the arrival of driverless autonomous vehicles represents a unique opportunity for fundamental change in urban mobility, it will only help to reduce the number of cars (reduce car ownership, car traffic and parking needs) and drastically improve mobility options, if they come as shared fleets integrated with public transport.

As automotive advances are reshaping the driving experience - turning drivers into passengers and pulling users at the centre of the mobility ecosystem – people's values, norms and attitudes towards shared mobility are shown to change significantly with the rapid spread of smartphones and new practices of sharing economy. Therefore, new predictors of travel mode choice, including technological and social innovations, are highlighted in the present study to explore the attitude-behaviour gap related to mobility choices.

Finally, it is worth stressing that this study has shed light on the drivers and challenges that car sharing operators face, both from a business model and city level perspective. Indeed, based on the operator's strategy, different impact levels have been highlighted.



## Introduction

Car ownership and related consumption of space for car parking is one of the most urgent challenged shared by European cities and towns – and not really well treated in European and national transport policies. Congestion is another effect of having too many cars on limited street space. In fact, traffic congestion costs amount to 2% of GDP in cities such as Stuttgart and Paris, and on-street parking takes up 50% of inner-city land space (Ellen MacArthur Foundation, 2015). According to a study done on US cities<sup>1</sup>, commuters can expect to spend more than 40 hours a year sitting in traffic by 2020.

However, whether because of convenience, safety, comfort, or choice of route and schedule, car travel is still the preferred mode of daily travel in some of the largest European cities (accounting for 45% in cities like Berlin or London<sup>2</sup>). Consequently, the challenge for urban planners today is to balance the demand for increasing personal mobility, with the need to respect the environment and provide an acceptable quality of life for all citizens. Experience has shown that adding new infrastructure is often expensive and slow. Therefore, urban planners and policy makers are interested in finding ways to make their existing infrastructure more efficient and encourage more use of alternative modes of transport.

Car sharing offers a car at your disposal without the need of ownership and has the potential to reduce the number of cars in cities (Perboli, Ferrero, Musso & Vesco, 2017) without reducing individual mobility. Indeed, it also reduces social costs such as road congestion, energy use, and noise and air pollution (Firnkorn & Müller, 2015). In the city of Bremen, each shared car proved to be the equivalent of taking 15 private cars off the road (Glotz-Richter, 2016). Similarly, each shared car in France proved to liberate 4 parking places, according to a study carried out by 6t in partnership with ADEME<sup>3</sup>.

Car sharing first made its debut in Europe in the 1980s in Switzerland, and in 1990 in Bremen and other German cities, long before the digital age and the sharing economy ever emerged. In fact, most organizations started out in environmentally concerned local communities that wanted to meet their mobility needs in a more sustainable way (Loose, 2014). At first, the general operational characteristics of these organisations were similar to the round-trip business model, where cars are picked up and returned to the same parking spot from which they departed. While the popularity of car sharing was local and never took off, it is a different story today, where growing urbanisation—particularly by younger people who are less dependent on car ownership—is changing mobility patterns and desires. In fact, car sharing is most effective and attractive when seen as a transportation mode that fills the gap between transit and private cars and can be linked to other modes and transportation services as a mobility package. Cities, as hotbeds of connectivity and innovation, can provide the right market conditions for shared vehicles to shift towards modal integration.

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<sup>1</sup> <https://www2.deloitte.com/insights/us/en/industry/automotive/digital-age-transportation.html>

<sup>2</sup> <https://files.lsecities.net/files/2015/09/New-Urban-Mobility-London-and-Berlin.pdf>

<sup>3</sup> French Environment and Energy Management Agency

Another particularly important factor that has significantly improved the experience of using shared vehicles (and has contributed to its growth), is the role of digital technologies. Digitisation and ICT have already brought transformative social and economic change, starting with the development of the Internet, to social media platforms and subsequently widespread smartphone and mobile computing device adoption. Smart technologies have made choosing, booking and using shared transport easier, while access to cars were eased through smart cards and later smart locks (Münzel, Wouter, Koen, & Taneli, n.d.). Beyond digitisation, innovations related to urban transport focuses on further electrification of urban mobility systems. Indeed, several European cities are already combining these strategies with car sharing services. The largest EV car sharing scheme is Autolib programme in Paris, with 3,923 vehicles and 1,086 stations (Autolib Métropole, 2016). Furthermore, the development of autonomous vehicles, when combined with the principles of car sharing, offers even more potential for a reorganisation of urban mobility. Likewise, pilot tests are being implemented in cities like Lyon, London and Rotterdam, to integrate shared fleets of AVs into the public transport network once they are ready<sup>4</sup>.

Finally, sharing economy practices emerging from 2008 are as well at the basis of the second wave of car sharing development. Whether classified under the label of rental economy, peer-to-peer or on-demand, these new forms of sharing economy practices are mainly driven by technology enablers (mobile devices), connectivity, environmental concerns, and global recession.

Given the disruptive force of the technology and societal innovations outlined above, which are undoubtedly impacting on urban mobility, it has become increasingly difficult to operate with a traditional 'predict-and-provide' model of urban transport planning. Technology co-evolves with society, which makes much technological change -particularly of the more disruptive kind- unpredictable. This uncertainty calls for a more integrated analysis of the underlying forces that affect urban travel.

The present report is intended to advance understanding of how mobility sharing practices are influenced by the arrival of digital technologies, transport innovations, the emergence of social innovation patterns and mobility behaviour and choices.

Specifically, we tried to answer the following questions:

- ★ What are the technology factors and transport innovations that are shaping the new era of mobility and particularly the future of car sharing? What is their impact on the mobility sector and their related challenges?
- ★ Which social innovation patterns are driving the new era of urban mobility?
- ★ How are car sharing adoption trends influenced by the evolution of sociodemographic characteristics, mobility behaviours and use of web 2.0 services?
- ★ What are the main drivers, barriers and KPI's to deploy car sharing in urban areas?

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<sup>4</sup> [http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief\\_Autonomous\\_Vehicles\\_LQ\\_20160116.pdf](http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief_Autonomous_Vehicles_LQ_20160116.pdf)

## READER'S GUIDE

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This report is structured in three parts:

**Part 1. Understanding the new era of urban mobility:** In this chapter, we explore the three types of underlying forces that are essential to understanding the new era of mobility and particularly the future of car sharing. These included technology enablers, such as ICT based innovations and automotive advances; Societal changes such as the emergence of new forms of sharing economy practices and Mobility as a Service; and attitudinal and motivational characteristics of citizens with regards to emerging urban transport opportunities.

**Part 2. Exploring the relationship between car sharing diffusion, socioeconomic factors and web 2.0 indicators:** The second chapter aims to advance understanding of how car sharing adoption trends are influenced by the evolution of sociodemographic characteristics (population characteristics, education level, income), car ownership rate and mobility split, and the use of web 2.0 services (participation in social networks, internet banking and the use of internet for travelling purposes). To do so, we undertook a complementary approach in which we analysed aggregated statistics for a time series in a given area, or the same statistics in different countries and cities. Car sharing data was gathered through different sources, including car sharing operators' websites, newspaper, annual surveys for the different car sharing systems, and statistical data at national and city level.

**Part 3. Use cases:** A specific analysis of three use cases was carried out with the objective of studying the main drivers, barriers and KPI's to deploy car sharing in urban areas. In Paris, Autolib was chosen as an example of a public electrical car fleet that operates as free floating with pool stations. In Bremen, Cambio provides a successful example of a round trip station-based carsharing operator that counts with the continuous support of the local government. And in Barcelona, Drivy offers an example of peer-to-peer carsharing start up that chose Barcelona as one of its internationalisation destination. The methodology undertaken to conduct the three case studies combines data from literature analysis and expert interviews. A multi-level perspective was then used to help analyse both the internal (business model and business performance) and external (city/local related) factors shaping the car sharing deployment in these urban areas.

# 1 Understanding the new era of urban mobility

## 1.1 Digital technologies and transport innovations enabling a new mobility ecosystem

The arrival of digital technologies and transport innovations has opened up new opportunities to make the existing transportation network far more efficient and user friendly. The combination of conventional and novel data sources, advanced data analytics, and new business models have enabled an array of new services to enter the mobility sector. In addition, recent developments, including improved digital connectivity and massive use of mobile devices, together with mobile internet access, have helped speed up this process.

**But what are these technologies about, why are they relevant and what is their impact on the mobility sector?**

This first part explores seven emerging technologies and trends that are the most promising for the mobility sector and that carry significant risks. The choice of technologies is based on the findings of 6 interviews carried out during this task. Interviews were conducted with the following profiles:

- One policy analyst at the International Transport Forum of the OECD (February 2018);
- Two car sharing operators in Spain and Germany (January 2018);
- One car sharing association in Germany (March 2018);
- One transport planner – City of Bremen, Germany (February 2018);
- One transport policy manager in the region of Ile de France (February 2018).

The seven technologies are as follows: The Internet of Things; big data analytics; artificial intelligence; blockchain; vehicle electrification; autonomous and connected vehicles; and mobile technology. The following sections describe each technology in turn, highlighting some of its impacts on the mobility sector (and in some cases specifically on car sharing) and exploring related challenges.

### 1.1.1 ICT-based innovations



#### Internet of Things

The Internet of Things (IoT) comprises devices and objects whose state can be altered via the Internet, with or without the active involvement of individuals (OECD, 2015). The term goes beyond devices traditionally connected to the Internet, like laptops and smartphones, by including all kinds of **objects and sensors which can communicate and share data among themselves**. The IoT is closely related to big data analytics and cloud computing.

While the IoT collects data and takes action based on specific rules, cloud computing offers the capacity for the data to be stored and big data analytics empowers data and processing and decision-making (OECD, 2016).

Automatic car sharing systems already started in 1993 with the installation of the first onboard computer, developed by a German firm called INVERS<sup>5</sup>. A parallel development took place in Switzerland where CONVADIS<sup>6</sup> built (and still builds) onboard computers for Mobility CarSharing<sup>7</sup>. Until then carsharing cars could be opened via chipcards and also opened and locked via remote connection. Location of carsharing vehicles was able to be tracked since the GPS standard was opened for public use in the mid-90s.

### Impact on the mobility sector

**The IoT holds great promise for the improvement of transport management and road safety.** Sensors attached to vehicles and elements of the road infrastructure may become interconnected, thereby generating information on traffic flows, the technical status of vehicles and of the road infrastructure itself. Already smartphones are actively used by navigation providers to monitor road usages with real-time traffic updates (OECD, 2015).

**The IoT holds great promise for the improvement of infotainment services while travelling.** As mentioned before, today certain functions are already implemented in new vehicles, but other functionalities could be added, such as remote diagnostic of the vehicle itself, allowing assistance or partner mechanics to set preventive maintenance.

Finally, existing research points out **four IoT essential functionalities for sharing mobility services** (apart from the existing vehicle availability tracking in real time and location and navigational data on vehicle) (Katalinic, 2015):

- Data transfer from car for the purpose of monitoring vehicle state (fleet maintenance)
- Enhanced fleet management

### Challenges

Globally, considering the unlimited volume of connected things, time and resources need to be devoted to fully develop the basic ability to identify and manage all of these devices. Moreover, as data volumes continue to increase, it puts a noticeable stress on the network as well as an increased challenge to secure the data gathered.

Finally, skills and data analysis are a key asset for the future, and not just for growth: social inequity is also likely to increase if the gap continues to widen between those who can and those who cannot keep up with IoT developments (OECD, 2016).

<sup>5</sup> <https://invers.com/>

<sup>6</sup> <http://www.convadis.com/>

<sup>7</sup> <https://www.mobility.ch/en/>

Companies running fleet-based car sharing programmes encounter several challenges related to the remote management of their fleet. Security, privacy and stability concerns play a great role in carsharing since the service is very dependent on that. Thus, carsharing platforms have a complex and advanced software and server-structure to be able to manage diverse fleets and cars with varied operational characteristics.

### BOX 1: The turn of conventional vehicles into a smart car sharing automobiles

A few smart shared-use vehicle tests were already implemented in Europe in the early 90s. Lufthansa Airlines, for example, instituted automatic rental systems at the Munich and Frankfurt airports in 1993, in which a computer released a key and started the billing. After the car was returned, the vehicle communicated distance traveled and fuel consumed to a central computer system. By the end of 1994, 12,000 employees at the two German airports had access to this new smart sharing system. Main cost savings for Lufthansa came from avoiding parking infrastructure costs and were used as a justification for corporate subsidies of the program. In only six years, the system was modernized with a smart card system and coordinated with local transit operators. A similar program, called "CarShare," was introduced in 1993 by Swissair at the Zurich airport for flight attendants. It was technologically simpler and worked in collaboration with Hertz Rent-a-Car Switzerland.

[\*A short story of car sharing in the 90s\*](#)



### Blockchain

Internet applications such as web browsers and email programs use protocols that define how software on connected devices can communicate with each other. Whereas the purpose of most traditional protocols is information exchange, **blockchain enables protocols for value exchange** (OECD, 2016). This technology facilitates a shared understanding on value attached to specific data and thus allows transactions to be done (without the necessity of a third party). This technology is expected to disrupt several markets by filling three important roles: recording transactions, establishing identity and establishing "smart contracts".

Impact on  
the  
mobility  
sector

**Blockchain holds great promise for (mobility-related) peer-to-peer transactions**, potentially changing the roles of intermediaries (that is, the companies that operate the marketplaces that facilitate this P2P exchange, and thus get a share of the deal). The potential inherent security of blockchain will allow individual car owners, but also fleet managers, to lease their vehicles to trusted and identified riders, with the transactions governed by smart contracts crafted on the go reflecting the terms and conditions agreed by the peers, with completely traceable trips recorded in the blockchain, and automatic payments flowing after each trip.

**Car blockchain systems could also enable car owners to grant others temporary access to their vehicles**, by simply using the app to unlock your vehicle remotely, giving a friend a chance to snag, for instance, something he forgot from the backseat. You could even grant a third-party delivery company, such as a grocery delivery service, the ability to unlock the vehicle to leave your order in the trunk.

**Blockchain holds great promise for facilitating financial transactions:** Companies like Porsche, have already seen the potential for car owners to use blockchain to pay for the electricity to charge electric cars. Imagine if every time you charged your vehicle, the action triggers a smart contract on the blockchain that takes the appropriate amount of money from your account and sends it to the charging station (Porsche, 2018). The financial applications could also extend to paying for the monthly car sharing subscriptions or insurance.

**Blockchain holds great promise for developing usage-based insurance** (Houser, 2018), by analysing driving behaviour and habits, and consequently offering lower insurance premiums to safe drivers, with a superior level of transparency and security over the whole data sharing process (comparing to the short-term insurance schemes existing today).



## Challenges

The proliferation of this blockchain is certainly threatened by technical and legal issues that remain unresolved. First, the initial cost since the software required to run blockchain technology in organizations must typically be developed for the specific firm and is therefore expensive to purchase, acquire or develop in-house. Indeed, organizations may have to obtain specialized hardware for use with the software. An additional uncertainty specific to smart contracts lies in the extent to which complex services can be sufficiently programmed into rules. In order for these networks to completely run by themselves (e.g. without a firm banking the service), instructions embedded in transfers should provide an exhaustive definition of the service (OECD, 2016). Privacy and security are also recurring issues. While all transfers conducted through blockchain are permanently recorded and immutable, it contains information only relative to agents' internet identity, which may not necessarily lead to their identity. Although the technology is revolutionizing many different industries, knowledge of the benefits of this technology is still limited to those who are involved in the technology space and those potential users (Bitcoin Magazine, 2018).

### BOX 2: Encouraging eco-friendly driving

In February 2018, Daimler launched a project based on their own **blockchain-based cryptocurrency, mobiCOINS**. For three months, a test group of 500 drivers will receive mobiCOINS when they operate their vehicles in environmentally friendly ways. These include coasting to a stop, switching the engine to ECO mode, and maintaining a low driving speed. The vehicle shares the driving data with a special app, which determines how many mobiCOINS the driver has earned. The coins are then deposited into the driver's account, with a blockchain recording every transaction along the way.

With enough mobiCOINS, a driver becomes eligible to win prizes, ranging from a trip to Berlin's Fashion Week to VIP tickets to the MercedesCup Final. This gives drivers an incentive to operate their vehicles in environmentally responsible ways, and perhaps some of the habits will even stick after the project ends.

Similar schemes could be envisaged for car sharing programs to maintain ideal fleet distribution, including incentives for users to return vehicles to optimal locations rather than leave them wherever it is convenient or to use car sharing at off-peak periods.

<https://blog.daimler.com/2018/02/12/mobicoin-testphase/>





## Big data analytics

Big data analytics is defined as a **set of techniques and tools used to process and interpret large volumes of data** that are generated by the increasing digitisation of content and the spread of IoT (OECD, 2015). It can be used to study relationships, establish dependencies, and perform predictions of outcomes, patterns and behaviours.

Big data analytics is a trend that could enable operators in the transport sector to gain greater insights on habits of end-users, which are constantly evolving. In addition to data, it can provide actionable information to carsharing operators, empowering them to target new customers and improve their daily operations, and thereby helping them strategize for long term profitability and growth.

### Impact on the mobility sector

**Big data analytics holds great promise for transport planners and decision makers.** Traditionally the data necessary for transport planning purposes has been collected in relatively small samples by the public sector, scaled up through the use of modelling software. The situation today has radically changed: the private sector is collecting large scale data for a multitude of purposes, providing real-time indicators as well as long-term trends for transport planners and decision makers.

**The arriving of Big data is helping traffic control centers respond more quickly to accidents and backups,** while helping individual travellers navigate their moment-by-moments decisions. Cities are beginning to use the digital exhaust generated from these devices in powerful new ways.

**Big data analytics holds a great promise for the improvement of car sharing services,** in the following ways:

- ★ **Customer Segmentation:** by categorizing customers, car sharing operators are able to identify their true end-users, from daily commuters to customers only using free-minutes offered by the operator;
- ★ **Supply vs Demand Analysis,** by analysing information on the idle times of vehicles for particular areas in the city.

### Challenges

There are many barriers that still prevent the widespread implementation of such approaches, including technical issues related to data formats, data quality and reliability, databases and analysis algorithms. However, data protection and security play one of the major concerns.

Big data analytics may incentivise the large-scale collection of personal data that could become accessible in ways that violate individuals' right to privacy. The recent Facebook scandal makes it clear: data must be regulated<sup>8</sup>.

Another recurring issue is if and how these data can be accessed by National Statistical Offices for statistical purposes as there are legal, institutional and commercial aspects to using the relevant information (OECD, 2017). As mentioned before, much of the transport relevant data collected from new data sources, the access to these data sets, and the capabilities to generate significant insights from these, remains in the private sector.

### BOX 3: Crowdsourcing roadside maintenance for better government

In July 2012, Boston launched a new project called **Street Bump**, an app that allows drivers to automatically report the road hazards (potholes and streets that need repaving) to the city as their owners drive over them. Before they even start their trip, drivers using Street Bump fire up the app, then set their smartphones either on the dashboard or in a cup holder. The app takes care of the rest, using the phone's accelerometer — a motion detector — to sense when a bump is hit. GPS records the location, and the phone transmits it to an AWS remote server. This application has sparked interest from other cities in the U.S., Europe, Africa and elsewhere that are imagining other ways to harness the technology. Indeed, future versions are on their way and may include early earthquake detection capability and different uses for police department.

In similar ways, cities could also envisage the use of big data analytics to improve sharing mobility services and public transport systems (by collecting citizen's reports on usage hazards).

<https://vimeo.com/38233136>



### Artificial intelligence

Artificial Intelligence (AI) is seen as the **ability of machines and systems to acquire and apply knowledge and to carry out intelligent behaviour** (OECD, 2016). This means performing a broad variety of cognitive tasks, e.g. sensing, processing oral language, reasoning, learning, making decisions and demonstrating an ability to move and manipulate objects accordingly. Intelligent systems use a combination of IoT, big data analytics, cloud computing and machine-to-machine communication, to operate and learn (OECD, 2015).

Although the idea of AI is not new, there are three factors fostering its recent acceleration: the development of big data analytics and deep learning, and the increased capacity of computing. These trends could have a significant impact on the automotive and mobility industries as they will bring new products and business models rather than only productivity improvements.

<sup>8</sup> <https://www.theguardian.com/commentisfree/2018/mar/19/facebook-data-cambridge-analytica-privacy-breach>

Fleet-based car sharing companies have the most to gain from advanced analysis of the data collected from the vehicles in their fleet, which is gathered in real-time in the new age of connected cars. All that information can be used by many stakeholders (traffic authorities, leasing companies, municipalities, vehicle manufacturers, insurers, emergency services, etc.) in the mobility space to improve processes (Microsoft IoT, 2017).

### Impact on the mobility sector

**AI holds great promise for the reduction of accidents and for the improvement of fleet safety:** Machine learning (ML) techniques will learn what are the different causes of road accidents; distraction, weather conditions, fatigue, vehicle failure... Having IoT sensors on-board will allow us understand in depth the reasons behind an accident and indeed predict, when a similar accident can occur again (with reasonable probability).

**AI holds great promise for improving on-demand public transportation:** On demand public transportation will consider both historical and real-time data to plan the most efficient routes according to the demand and capacity.

**Effective routing is another area where AI could have an impact on the environment:** Tracking operator patterns (order picking, inventory monitoring, and field force) combined with predictive orders in certain areas can minimize the delivery times and optimise stock levels at warehouses. Similarly, drivers could start using smart routing programs to find the most fuel-efficient path from one point to another. Further, AI can provide assistance in identifying open parking in a timely manner, reducing the time we spend looking for a parking.

**Big data analytics holds a great promise for the improvement of car sharing fleet management and maintenance:** Data collected from their vehicles on the fleet can include anything from location, mileage, fuel consumption and driving behaviours, all of which can be used not only to improve management but also to reduce vehicle misuse by drivers. On the other hand, predictive maintenance algorithms will detect a potential failure based on statistical data from same models with similar driving conditions.

### Challenges

First, AI can make mistakes that result in potentially serious damage. Indeed, the imperfect nature of AI raises questions about the principles of legal responsibility (between AI constructors, programmers, owners...). Second, laws and legal frameworks will need to be devised and implemented before many of the benefits in AI can be reaped in markets like transportation. Moreover, there are also significant concerns on security, particularly related to AI not being hacked or programmed maliciously. This should be taken into account in early phases.

In relation to car sharing, the major obstacles standing in the way of fleet-based operators are the large amounts of data generated, and the various formats in which they are provided. Operators may lack the knowledge and time to effectively use this information.

#### **BOX 4: A way to simplify fleet management**

Fleet management software solutions in the market can transform real-time data on fleet activities into useful information that shared-mobility operators can act on. This type of solutions, for instance, may allow car sharing operators understand mobility flows and how fuel consumption is impacted by driving habits, time of day spent driving, and the type of vehicle.

Transport policy makers could envisage to use this type of solutions to understand the changing relationships between commuting CO2 emissions, travel behaviour and urban forms, and predict mobility flows.

<https://www.geotab.com/fleet-management-solutions/fleet-optimization/>

#### **BOX 5: Predicting parking difficulty**

In February 2017, Google launched a new feature for Google Maps across 25 US cities that offers predictions about parking difficulty close to your destination so you can plan accordingly.

Providing this feature required addressing some significant challenges, like the variability of parking availability, the complexity of traffic flows in parking (across many levels), people parking illegally or departing early from still-paid meters...

To face these challenges, this feature uses a unique combination of crowdsourcing and machine learning (ML) to build a system that can provide you with parking difficulty information for your destination, and even help you decide what mode of travel to take — in a pre-launch experiment, they saw a significant increase in clicks on the transit travel mode button, indicating that users with additional knowledge of parking difficulty were more likely to consider public transit rather than driving.

Three technical pieces were required to build the algorithms behind the parking difficulty feature: good ground truth data from crowdsourcing, an appropriate ML model and a robust set of features to train the model on.

<https://blog.google/products/maps/know-you-go-parking-difficulty-google-maps/>

## 1.1.2 Automotive advances



### Electrification

Electrification of urban mobility systems focused in the last century on electric railways, trams and elevators. In contrast, this second wave of electrification focuses primarily on allowing electric vehicles (EVs) to operate with stored electricity, eliminating the requirement for constant grid connection.

Annual sales of battery-powered EVs and hybrids will increase from about 2.3 million units in 2014 to 11.5 million by 2022, or eleven percent of the global market, according to IHS, a market research firm<sup>9</sup>. We are certainly closer to the 100 percent of new vehicles sold in 2025 in the developed world that will be electrified (either as hybrids or full battery electric vehicles) (International Energy Agency, 2017). This shift is already seen in most traditional automobile, bus and truck manufacturers, as significant parts of their research and development budgets are allocated to the field of electric motors and batteries. Furthermore, every funded automobile start-up of any significance is wholly focused on EVs (Neckerman, 2017).

The second EV tech push is mainly driven by the high level of transport related emissions in urban areas<sup>10</sup> and air quality issues. However, it should be noted that the use of EVs in urban areas does not help in reducing congestion and space consumption for parking (two of the most urgent problems in all cities and the reason for promoting car sharing).

#### Impact on the mobility sector

**EVs hold great promise for car sharing schemes in cities:** As mentioned before, municipalities looking to control pollution in congested city centres are actively encouraging the use of EVs in car share services (International Energy Agency, 2017). This dynamic is stronger in inner areas of cities, where driving distances are shorter, and people are less worried about running out of power. Autolib (France), BlueIndy (Indianapolis), Drivenow (Denmark), Toyota's CitéLib (France) and Carma (San Francisco), are some examples of ongoing EV car sharing programs. However, it should be noted that mixed fleets allow to have also cars for all usual travel purposes – a pre-requisite for replacing private cars.

<sup>9</sup> <https://ihsmarkit.com/industry/automotive.html>

<sup>10</sup> Urban mobility accounts for 40 % of all CO2 emissions of road transport and up to 70 % of other pollutants from transport < [https://ec.europa.eu/transport/themes/urban/urban\\_mobility\\_en](https://ec.europa.eu/transport/themes/urban/urban_mobility_en)>

**EVs hold great promise for controlling CO<sub>2</sub> emissions in congested city centres:** Energy technology and energy utility companies increasingly own and operate charging stations, while cities provide public land as a free concession for a certain number of years and under specific service level agreements. Cities also rent out their parking slots at night and offer charging options to EV owners.

## Challenges

Despite this positive outlook, it is undeniable that the current electric car market uptake is largely influenced by the policy environment. Key support mechanisms include R&D on innovative technologies, mandates and regulations, financial incentives and other instruments (primarily enforced in cities) that increase the value proposition of driving electric. Public procurement is also well suited to facilitating early EV uptake (leading by example). The deployment is also supported by the development of standards ensuring interoperability, financial incentives, regulations (including building codes) and permits.

Moreover, the innovative uses and services associated to batteries or to the integration with smart buildings are not enough explored. In fact, electric mobility still continues to be associated to traditional ownership and use models. Charging stations are not always available, or still do not exploit enough digital technologies, over-complicating the customer experience (World Economic Forum, 2018). Finally, an interview to an EU car sharing association, revealed that customers of car sharing services are reluctant to EV technology because on average they do not want to invest the energy to learn about EVs; thus EVs in carsharing in Germany, for example, have only one third of the bookings of ignition engine cars (personal communication, February 2018).

## BOX 6: Encouraging electrifying fleets, car sharing and other mobility services

- ★ **Public fleets:** The city of Oslo (Norway) plans to have its fleet of 1,200 using electricity by 2020 and to increase their usage by sharing them between city-hall employees and citizens.
- ★ **Taxis:** The Transport for London office requires all new black cabs to be electric or emission free, and diesel vehicles will not be permitted in London by 2032. A total of 80 charging stations will be dedicated to black cabs, with plans to implement 150 by the end of 2018 and 300 by 2020.
- ★ **Car sharing:** The region of Ile de France and private partners developed Autolib, an electric car sharing service with 4,000 EVs and 1,100 charging stations, with more than 6,200 charging points across the region, accessible to service users and other EV owners (see Case study 1 in section 3.1).
- ★ **Last-mile delivery services:** The city of Dortmund (Germany) is developing non-financial incentives for last mile delivery companies to electrify their fleets: EVs receive permission for extended access to the city centre.

[http://www3.weforum.org/docs/WEF\\_2018\\_%20Electric For Smarter Cities.pdf](http://www3.weforum.org/docs/WEF_2018_%20Electric%20For%20Smarter%20Cities.pdf)

## BOX 7: Serving low-income neighbourhoods

**BlueLA Electric Car Sharing Program** in Los Angeles targets lower-income families who can't afford eco-friendly cars. This new car sharing program has introduced 100 vehicles and 200 EV charging stations. BlueLA hopes to recruit 7,000 commuters in 2018 and deploy 1.5 million electric vehicles around the state by 2025. The program will target disadvantaged communities that are positioned near freeways, refineries, and other heavily polluted areas. The effort is part of the mayor's plans to improve CO2 emissions city-wide. The cars will be available 24/7 at self-service kiosks and can be rented by the minute or via a monthly subscription.

<http://www.latimes.com/business/la-fi-blueela-20170609-story.html>



### Connected and autonomous vehicles

"Autonomous Vehicles" (AVs) are expected to use information from on-board sensors and systems to understand their global position and local environment, enabling them to operate with little or no human input for some, or all, of their journey. "Connected Vehicles", on the other hand, are expected to have the ability to communicate with their surrounding environment (including infrastructure and other vehicles), and to provide information to the driver that informs decisions about the journey and even activities at the destination (Transport System Catapult, 2017). Finally, "CAV technologies" are defined as the on-vehicle technologies that provide CAVs with their autonomous and/or connected capabilities. This includes software (such as computer imaging and safety critical systems) as well as hardware (such as radar, LIDAR and GPS receivers).

The arrival of driverless autonomous vehicles (defined as 100 percent autonomous driving of a vehicle without an actual driver to override the system) represents a unique opportunity for fundamental change in urban mobility. However, a path based mainly on individual ownership of autonomous cars would not exploit the potential of autonomous vehicles for sustainable transport but could lead to an increase of vehicle mileage without reducing car ownership and related space consumption. Such a scenario could serve to reduce already-low average vehicle occupancy to less than one as vehicles move around the city with no occupants. Indeed, it should be noted that according to UITP's latest Policy Brief on the topic<sup>11</sup>, AVs will only help to reduce the number of cars (reduce car ownership, car traffic and parking needs) and drastically improve mobility options, if they come as shared fleets integrated with public transport (see Figure 1).

Indeed, several possible applications could be envisaged as part of a diversified public transport system:

- ★ Autonomous car sharing vehicles;
- ★ AVS as feeders to public transport stations;

<sup>11</sup> [http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief\\_Autonomous\\_Vehicles\\_LQ\\_20160116.pdf](http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief_Autonomous_Vehicles_LQ_20160116.pdf)



- ★ AVs as robo-taxis and on-demand shuttles;
- ★ Area based on demand autonomous mini buses.

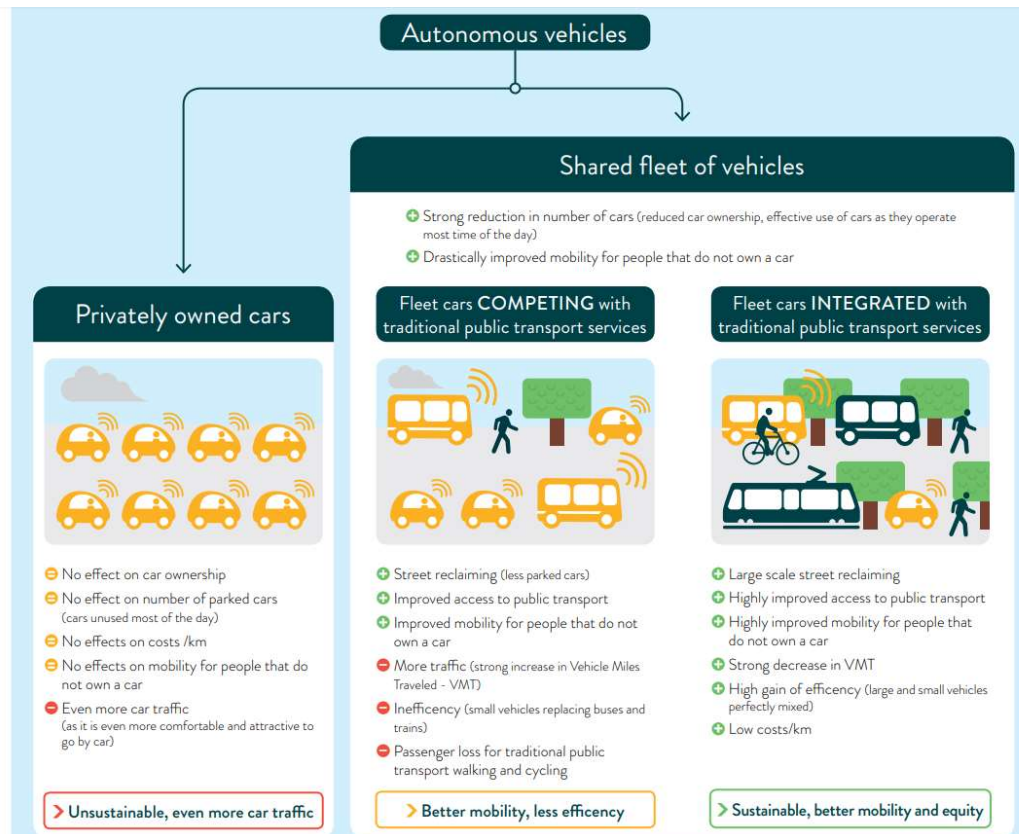


Figure 1: Opportunities of shared fleets integrated with traditional public transport systems (UITP, 2017)

### Impact on the mobility sector

**AVs offer the opportunity to provide more public transport options** to people in locations where it was difficult or impossible before because of high operational costs.

Moreover, **AVs as car and ride sharing will reduce parking pressure and car traffic** and holds a great promise for **implementing Mobility as a Service**.

**By reducing the human factor behind the wheel, autonomous vehicles could also provide much safer roads**, as today 1.2 million worldwide a year die in automobile-related deaths and 90% of the accidents are due to human error. In the short term, measures such as adaptive speed limitation and pedestrian/obstacle detection systems with automated braking systems could reduce accidents already.

**CAV holds great promise for increasing the number of shared trips:** AV cars could have a specific importance for the first mile/ last mile feeder functionalities. Today, you reserve a shared car and pick it up; tomorrow, you reserve it and it picks you up. Today, with the increasingly expanding free floating option, you can pick up a shared car in one location and drop it off in another location; tomorrow, it will pick you up in one location and drop you off in another.



Different operational environments will require different solutions; some of them better suited to AVs, some less (Hanon, McKerracher, Orlandi, & Ramkumar, 2016); e.g. dense historic cities or mega-cities might be more appropriate for high-capacity collective modes, but suburban areas might benefit from completely new transport options, as an alternative to the privately owned car (Bouton, Knupfer, Mihov, & Swartz, n.d.).

## Challenges

Although it seems clear that CAVs are coming, we do not know yet how they will be rolled out in cities as this also largely depends on how they will be regulated. Indeed, the number of cars with some sort of networking ability today is small, perhaps only 8% of the global total and therefore, the build-up will be relatively slow because many old cars stay on the road for a decade or so<sup>12</sup>.

In the transition period, there will be a large element of interaction between manually operated vehicles and automated vehicles (the level of automation can also vary amongst fleets and amongst the composition of vehicles using the road network simultaneously).

Moreover, CAVs must overcome challenges to safety, cost, and customer perceptions. Indeed, if electric vehicles are used, a very likely technology option for a number of reasons, then designing and providing the necessary charging infrastructure (offline, or online e.g. at stops or junctions), scheduling of charging of vehicles, and routing to charging stations needs to be considered as part of the overall service planning.

Furthermore, vehicle and system operation options will depend on provision and level of connectedness using wireless technology. This is particularly important with the emergence of both smart infrastructures with embedded sensors and the IoT. As mentioned before, with increasing importance of digital infrastructure there is the need to ensure the robustness of the digital infrastructure system (data protection and privacy) and of data coverage. A central control or supervisory system will be needed for public transport fleets, relying on reliable communication systems.

Finally, other physical infrastructure might still be required in the transition period; this includes separate lanes, different types of barriers to limit access to parts of the network and special provisions for junctions; potential negative effects on urban design including visual intrusion and the risk of community severance need to be carefully considered.

<sup>12</sup> <https://www.economist.com/news/technology-quarterly/21615060-way-cars-are-made-bought-and-driven-changing-mobile-communications>

In the case of shared AVs, the following threats are pointed out on UITP's latest Policy Brief on the topic<sup>13</sup> :

- ★ Limits in technology or lack of public acceptance could prevent driverless operation within the foreseeable future;
- ★ Traffic volume increase through empty AV cars;
- ★ Reduction in number of driver/chauffeur jobs;
- ★ AVs as a robo-taxis are a business opportunity for private firms (Uber, Google, Amazon, car manufacturers). This could lead to the privatization of urban transport services with a loss of influence for public authorities.

### BOX 8: Shared automated shuttles paving the way

One of the first real world application of a shared automated shuttle carrying passengers was the **ParkShuttle in the Rivium Business Park near Rotterdam in the Netherlands**, operating on a number of stops on a loop connecting offices with a nearby public transport interchange. This system opened to the public in 1999. A similar system connecting the long-stay car park with the main **terminal building of Shiphool airport (UK)** has been set up as a multi-year demonstration project. Both systems, although segregated from other traffic in some parts of the route, were able to operate safely in controlled but mixed environments with manually driven vehicles and pedestrians. The Rivium system has been extended, with second generation vehicles, and is still operational to date. Similar kinds of shuttles are now being tested around the world:

In **Lyon (France)**, for example, an autonomous shuttle service has been running on the banks of the river Saone since September 2016, providing easy access to businesses, as well as shopping and restaurant areas. It was designed with intermodality in mind as the shuttle service is situated just a few metres from the tram stop serving the Confluence eco-neighbourhood.

In **Singapore**, a massive effort is underway to achieve the 2013 Singapore Land Transport Masterplan that aims to promote public transport as the mode of choice. On the service provision side, it will offer first-and-last mile connectivity as well as on-demand services through a demand-responsive fleet of shared autonomous vehicles. Numerous pilot tests are implemented to integrate AVs into the public transport network once they are ready.

[Vehicle automation for shared mobility](http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief_Autonomous_Vehicles_LQ_20160116.pdf)

[http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief\\_Autonomous\\_Vehicles\\_LQ\\_20160116.pdf](http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief_Autonomous_Vehicles_LQ_20160116.pdf)

<sup>13</sup> [http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief\\_Autonomous\\_Vehicles\\_LQ\\_20160116.pdf](http://www.uitp.org/sites/default/files/cck-focus-papers-files/PolicyBrief_Autonomous_Vehicles_LQ_20160116.pdf)

### 1.1.3 Mobile technology



As automotive advances are reshaping the driving experience - turning drivers into passengers and pulling users at the centre of the mobility ecosystem - opportunities for transformation are arriving on the heels of the **explosion of mobile technology and especially the rapid spread of smartphones**.

Mobile devices have reached a tipping point as both the number of users and total usage (time spent per day) now significantly overtake other forms of digital connectivity, such as desktop and laptop computers<sup>14</sup>. In 2016 in Europe, mobile phones or smart phones were the device most used to surf the internet, by over three-quarters (79%) of internet users. They were followed by laptops or netbooks (64%), desktop computers (54%) and tablet computers (44%). According to Eurostat, the highest shares of surfers via mobile phone or a smartphone in 2016 were registered in Spain (93% of those having used the internet), ahead of Cyprus and the Netherlands (both 88%), Croatia (87%)<sup>15</sup>.

#### BOX 9: Transforming smartphones into car sharing keys

Until now, the majority of car sharing fleet systems relied on direct communication between components installed in vehicles and a central management system. Tech providers dedicated to shared mobility are now bringing new solutions to the market that enable car sharing operators to offer car-sharing based solely on smart phones, regardless of the vehicle's manufacturer. In effect, these solutions introduce the use of a smartphone with Near Field Communication (NFC) technology to quickly and safely manage access to vehicles enabling users to directly interact with the vehicle using a device they already own, even if their smartphone is out of range of network coverage or runs out of battery.

After initially registering to the service, users will be able to immediately find vehicles in the area using their smartphone and book the one of their choice. Digital keys will be sent remotely and in a secure way via a secure IOT Cloud to the user's device. The user will simply have to place the smartphone close to the windshield to unlock the door. The NFC receiver installed in the cars will then ensure the secure communication between the user's device and the car and will also enable the remote management of the access rights at the car level. In case of device loss or theft, the digital key will be disabled remotely to avoid misuse.

<https://www.realwire.com/releases/Next-generation-car-sharing-technology-with-the-INVERS-CloudBoxx>  
<http://www.oberthur.com/ot-and-octo-telematics-revolutionize-car-sharing-with-easyopen-by-omoove-a-service-powered-by-ots-secure-iot-cloud/>

<sup>14</sup> <http://www.smartinsights.com/mobile-marketing/mobile-marketing-analytics/mobile-marketing-statistics/>

<sup>15</sup> <http://ec.europa.eu/eurostat/documents/2995521/7771139/9-20122016-BP-EN.pdf/f023d81a-dce2-4959-93e3-8cc7082b6edd>

## 1.2 Societal changes

### 1.2.1 New forms of economy

Collaborative consumption and the sharing economy have become social and economic phenomena in just a few short years. “I don’t need a drill. I need a hole in my wall”. This saying has been out for many of those engaged in shared communities and it represents the main idea behind shared economy. There are some variations on the definition of shared economy, but there are three overlapping across these variations. The first is that at **shared economy permits underused resources and assets to be shared by different users**. The second is that **the provider of assets may be companies or individuals**. The third is that the collaborative economy is **driven and enabled by digital technology and infrastructure** that makes possible the economies of scale necessary users to integrate in the shared community (Canales et al., 2017).

According to a study developed in 2015 by Pais and Provasi ([Pais & Provasi, 2015](#)), there are six different types of sharing economy practices applied in sectors, such as hospitality, transport, entertainment and financing.

- ★ **Rental economy practice:** It comprises rental schemes run by companies specialising in goods, which are generally under-used when the users have exclusive private ownership of them (for example, car and bike sharing services).
- ★ **Peer-to-peer economy practice:** It concerns goods that are also under-used, but which are offered by their owners (for example, Airbnb<sup>16</sup> in the housing sector and Drivy<sup>17</sup> or CarAmigo<sup>18</sup> in the mobility sector).
- ★ **On-demand economy practice:** It is characterised by the use of platforms that broker personal services provided by professionals and non-professionals (platforms such as Uber<sup>19</sup> or Blablacar<sup>20</sup>).
- ★ **Time banking and local exchange trading systems:** similar to the previous one in terms of the services offered, but this shows a fundamental difference in the lack of money in the transactions, employing instead alternative currencies or time as the unit of value of the services exchanged (for example TimeRepublik<sup>21</sup>, a marketplace which by trading their services with other community members, users of the system earn time credit units or hours. In return, they can spend those credits with any other member in the system by paying for their services with time).

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<sup>16</sup> [www.airbnb.com](http://www.airbnb.com)

<sup>17</sup> [www.drivy.com](http://www.drivy.com)

<sup>18</sup> [www.caramigo.eu](http://www.caramigo.eu)

<sup>19</sup> [www.uber.com](http://www.uber.com)

<sup>20</sup> [www.blablacar.com](http://www.blablacar.com)

<sup>21</sup> [www.timerepublik.com](http://www.timerepublik.com)

- ★ **Social lending and crowdfunding:** it is about the application of finance to a sharing economy, including direct loans between people and platforms that help raise the capital necessary for the development of a new idea among those potentially interested in it (funding platforms for creative projects, like Kickstarter<sup>22</sup>).

As stated, these new forms of economy practices have undergone significant growth since 2008. In effect, existing research points out that this is the result of the interlinking of four types main driving forces, including technology enablers, environmental concerns, global recession, and the network paradigm.

The supposed benefits of a transition from ownership economies to access, collaboration and sharing have not convinced everyone yet. A survey conducted by PwC in 2015 (PwC, 2015) with 1000 US consumers showed that 44% of the respondents are familiar with new forms of economy and that their engagement was mainly with the entertainment and media sectors. Around 76% to 89% agreed that sharing economy makes life more affordable, convenient and efficient; that it is better for the environment; that it builds a stronger community; that it is more fun than traditional companies and that it is based on trust between providers and users. However, 72% of the respondents agreed that they feel that the sharing economy experience is not consistent and 69% agreed that they will not trust sharing economy companies until they are recommended by someone they trust.

Critics of these new forms of economy identify several concerns related to legal compliance, taxation minimisation, labour laws, regulatory frameworks, and adverse social or economic consequences. Indeed, the most widespread peer to peer and on demand economy platforms such as AirBnB and Uber, are currently facing serious problems related to essentially two of these issues<sup>23</sup>: Tax avoidance and deregulation of the labour market. Moreover, critics of peer-to-peer practices also argue that consumers can more easily turn their consumer goods into capital assets to earn rents, and such valuable consumer goods are typically concentrated in a small group of well-off people. This is again more evident in the housing sector, but also applies to peer to peer car sharing, in which car ownership reduction is questioned (since people can now finance their private car by renting it out). Overall, while it is safe to say that participants in the sharing economy are experiencing increases in consumer welfare from lower prices and more variety, economic inequality driven by provider side dynamics is likely to increase as well (Koen & Schor, 2017).

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<sup>22</sup> [www.kickstarter.com](http://www.kickstarter.com)

<sup>23</sup> The Guardian (2014). [Airbnb's legal troubles: what are the issues?](#); The New York Times (2015): [Airbnb is a problem for cities like New York and San Francisco?](#); The Telegraph (2016): [Uber loses landmark tribunal decision over drivers' working rights](#); The Guardian (2016): [Airbnb faces worldwide opposition. It plans a movement to rise up in its defence](#)

**BOX 11: Crowd-sourcing and collaboration for improving traffic data**

Waze seeks to solve road-traffic issues by creating local driving communities that work together to improve the quality of everyone's driving. And how? By crowd-sourcing traffic data, analysing and disseminating pertinent information. Instead of passively providing route guidance assuming traffic conditions are static, Waze differentiates itself by using live feedback produced by its users to generate real-time traffic reports. It then adjusts its route guidance accordingly and communicates the changes to users.

Since its founding in 2007, Waze has collected and continues to accumulate a wealth of data that can be used to generate significant value for the company. More specifically, Waze captures the commuting habits users—when they drive, what they pass by on their way, and the location they ultimately travel to—and uses that data to sell location-based advertising to advertisers.

Although it is not a sharing economy practice strictly related to car sharing, this type of collaboration platform has proved to enhance the driving experience of tens of millions of users. As restaurants use Waze to alert users when a consumer is near a restaurant's location (more valuable for advertisers than showing the same add on a website), cities could also use it to target commuters more effectively. This could include alerts of others users interested to carpool, or information of other means to get into a city without the car (public transport with parking areas, car sharing services...).

<https://www.waze.com/en-GB/livemap>

### 1.2.2 Shared mobility

Shared mobility describes a variety of business models that share modes of transport among users. The range may go from car, bike and moto sharing, to carpooling or ride sharing (Paundra, Rook, van Dalen, & Ketter, 2017).

As seen before, these models, enabled by technological and transport innovations, have great potential to deliver concrete financial and environmental benefits to society. By Deloitte's calculations, doubling the number of rideshare commuters (which would simply bring the percentage back up to 1970 levels) and shifting 10 percent of lone drivers to car sharing, could take nearly 16 million lone drivers off the road and save 757 million hours annually wasted in congestion<sup>24</sup>. Carbon dioxide emissions would decline by roughly 2 percent in the United States alone.

A promisor scenario that may increase the market for car sharing and the variety of shared mobility is the implementation of Mobility-as-a-service (MaaS), a concept first created in Finland. MaaS is *"The provision of transport as a flexible, personalised on-demand service that integrates all types of mobility opportunities and presents them to the user in a completely integrated manner to enable them to get from A to B as easily as possible"* (Burrows & Bradburn, 2014).

In the MaaS perspective, consumers can have control on their decisions of commuting and the service includes different platforms: car sharing, bicycles and public transport. Those services provide

<sup>24</sup> [https://www2.deloitte.com/content/dam/Deloitte/es/Documents/sector-publico/Deloitte\\_ES\\_Sector-Publico\\_Digital-age-transportation-The-future-of-urban-mobility.pdf](https://www2.deloitte.com/content/dam/Deloitte/es/Documents/sector-publico/Deloitte_ES_Sector-Publico_Digital-age-transportation-The-future-of-urban-mobility.pdf)

journeys to facilitate daily commuting such as hospital appointments and school transport, with the potential to promote inclusion for elderly and people living in isolated areas.

Many changes have occurred in the transport sector and one main contribution for these long strides on the services is the use of technology and internet based services. Concerning the final users, the use of social media and apps is part of the consumer behaviour of shared mobility. A big facilitator is the use of smartphones which allows consumers to have real-time access to time tables, routes, traffic information, connections, taxi availability or spots for sharing cars.

In the discussion of (*Mobility As a Service: Implications for Urban and Regional Transport*, 2017), MaaS is pointed as an opportunity to promote sustainable travel, to improve efficiency of existing transport services and resources, to develop an inclusive transport system (especially for vulnerable categories of society), to offer choice to users and to enhance access to transport services.

#### **BOX 12: Combining the offerings of various mobility providers in a single app**

In order to become really attractive and form a credible alternative to car ownership, the different sustainable modes need to be coordinated, planned and delivered in an integrated way. From a physical perspective (coordinated network planning, stations, urban planning, and algorithmic optimisation of autonomous fleets) but also from an information perspective: a one-stop-mobility shop acting as a personal mobility assistant offering travel information, booking and ticketing.

In many cities, public transport companies are also providing Mobility as a Service-platforms to provide combined mobility to their customers. For example, in 2017 the city of Vienna launches the mobility app WienMobil to offer simple and convenient access via the Wiener Linien app not only to bus, tram and metro services but to all publicly available mobility services such as e-loading stations, parking garages, taxis, Citybike, car sharing, car rental and many more. The result is a one-stop mobility shop that, in addition to accessing real-time information, enables the user not only to buy tickets, but also to book, reserve and pay for other combined transport.

<https://www.wienerlinien.at/eportal3/ep/channelView.do/pageTypeId/66533/channelId/-3600061>



## 1.3 Mobility attitudes and behaviour in the context of new and emerging urban transport opportunities

This section covers the third type of underlying forces shaping the new era of urban mobility: **the broader attitudinal and motivational characteristics of citizens with regards to emerging urban transport opportunities; the possible relation with use of apps and social media via Web and smartphones; and the degree to which these attitudes may be an important factor in anticipating future changes in travel behaviour.**

The body of this discussion is divided into three sections. Section 1.3.1 and 1.3.2 pretends to give some insights on the travel attitudes and choices, based on the literature. Section 1.3.3 proposes an integrated model to explain the use of shared mobility and applications, based on both the theoretical and empirical work previously investigated.

### 1.3.1 Behavioural change in the context of mobility

The psychological dimension of behavioural change in transport has been poorly understood to date, although the field has seen an increase in transport studies applying psychological models to explain mobility choices and other aspects of daily travel. This section aims to introduce the most accepted definitions to the concepts of attitudes, values and motivations and the most applied frameworks to explain the choices of transportation.

#### ★ *Attitudes*

Attitude towards a behaviour is the valence and degree of the behaviour evaluation. It may be favourable or unfavourable, positive or negative (Ajzen, 1991). Attitudes may be addressed to all sorts of objects/persons (such as driving car, taxes policies, government, etc) and it is generally agreed that it has two components, a cognitive dimension (related to beliefs), and an affective dimension (related to emotions).

In addition to beliefs and feelings, attitudes are also agreed to manifest themselves in behaviour, although this is not always the case. For example, a person may have a positive attitude towards cycling to work, based on both beliefs and feelings, but never actually perform this behaviour (an attitude-behaviour gap). Another person may have the same attitude and behave in a way that corresponds with this (they do cycle to work).

#### ★ *Values* – a particular kind of attitude

When considering attitudes, it is also important to consider values, in that they are a particular kind of attitude - they also have both a cognitive and an affective component but differ from attitudes in that they are not tied to specific situations or objects. Values tend to be single, stable beliefs, used as standards to evaluate action and attitudes. Values are most central in a person's belief system and it is because of this centrality that values are particularly difficult to change (Herbelein, 1981).



For example, an individual may value 'the protection of the environment' but expresses two different attitudes in relation to it – such as a positive attitude towards cycling instead of commuting by car and a negative attitude towards driving to local shops instead of walking.

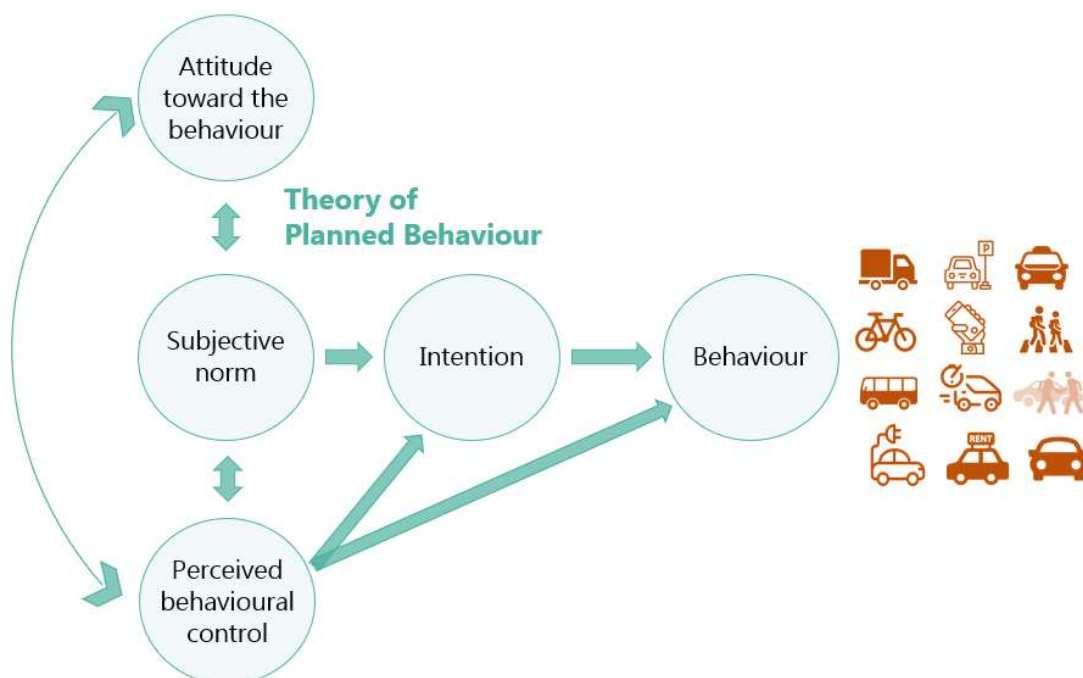
In relation to mobility specifically, values such as "free choice" are particularly relevant - people often consider ownership and use of the car their 'right' and express resentment if their freedom of choice in this context (in their opinion) is unfairly challenged (as found by (Herbelein, 1981) and (Jakobsson et al., 2000) in relation to road pricing).

### Linking attitudes and behaviour:

Having introduced the concept of attitudes and values, we discuss in the following the most used models to explain the choices of transportation. These examples may serve as guidelines for future research, and to shed light on the **complexity of attitudinal and motivational factors as predictors of travel mode choice**.

#### ★ **TPB** – The Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is based on the Theory Reasoned Action (TRA) and is one of the most widely applied models to explore the attitude-behaviour gap related to mobility choices and other aspects of daily travel. It was developed in the context of behavioural psychology, and states that individual behaviour results from beliefs as to anticipated consequences of an action (Ajzen, 1991, 2012). As shown in Figure 2, these beliefs are further influenced by personal values, perceived social norms and the perceived feasibility of an action.



**Figure 2: Theory of Planned Behaviour, adapted from (Ajzen, 1991).**

As summarised by (Bamberg & Schmidt, 2003), the TPB assumes that in choosing a behaviour, individuals take into account the following factors:

- **Behavioural beliefs** about the likely outcome of behaving in a certain way (such as the cost of using the metro, or reduction in greenhouse emissions caused by cycling to work instead of driving a car), which lead to the **formation of attitudes towards the behaviour**;
- **Normative Beliefs** about social pressure to perform or not the behaviour (such as the pressure felt in relation to learning to drive) which lead to the formation of subjective or **'social' norms with respect to the behaviour**;
- **Control Beliefs** about the confidence of an individual in their ability to perform a specific behaviour (i.e. as having a metro station close to the house or having enough money to drive a car), which influence the level of **perceived behavioural control** an individual feels. Perceived behavioural control may reflect past experiences, as well as anticipated barriers, based on observations and or beliefs.

In general, **the more favourable attitudes and subjective norm and, the greater the PBC, and the stronger would be one's intention to perform a behaviour** (Ajzen, 1991).

### ★ **Motivation**

Three main lines of research in environment have focused on motivational factor to promote pro-environmental behaviour, including travel behaviour (Steg & Vlek, 2009). The first line has focused on the **reasoned choices** that people make to maximize their benefits and reduce costs (in terms of money, time, and/or social approval). The TPB framework is one influent example of this line of research. The second line has focused **on moral and normative concerns** to act pro-environmentally. The models of norm-activation (NAM), the value-belief-norm theory of environmentalism (VBN) and the theory of normative conduct are the main influential examples of this range of studies. The third line has focused of affective and symbolic effects to explain pro-environmental behaviour.

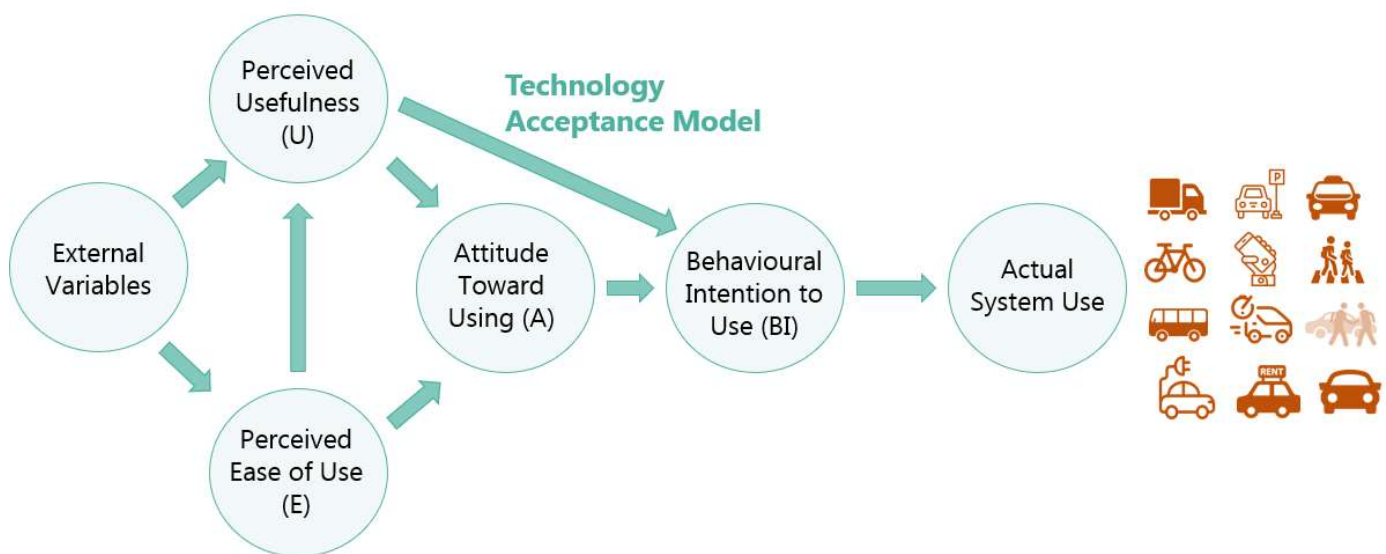
### ★ **Model limitations**

The research on attitudes and motivation have shed light in many psychological aspects that was underestimated in the research of travel mode choice so far. However, it should be considered that **travel behaviour has a habitual nature, which means that, most people already have specific habits when traveling during their daily-routines**. Unless an unexpected event occurs (closing of main road because of bad weather) or a structural change occurs (changing address), it is most probable that people will perform their habitual behaviour (Gärling & Axhausen, 2003). Research has shown that people with strong habits for commuting do not engage in activities to get new information about their behaviour. However, a temporary structural change may unfreeze old habits and change the choices of modes of transport (Verplanken, Aarts, & Knippenberg, 1997). For example, offering a one-month free bus ticket has the potential to change habit, attitude, and travel mode choice (Fujii & Kitamura, 2003).

The TPB and the motivational perspectives of research have not focused in the habitual characteristic of travel behaviour and the effects of daily routine. **Habits and past behaviour have shown to be the main predictors of behaviour for different transportation contexts** (Itzhakov, Uziel, & Wood, 2018; Lanzini & Khan, 2017; Ouellette & Wood, 1998). In a context with new demands for use of technology (e.g. applications and web), there will also be a demand for formation of new habits for planning trips and for choosing modes of transportation.

### ★ **TAM** – The Technology Acceptance Model

The Technology Acceptance Model (TAM) was also based on TRA and was precisely conceptualized to explain the adoption of new IT systems by users in a work context. However, adaptations to explain the adoption of new technology in a variety of fields exist (Davis, 1989).



**Figure 3: The Technology Acceptance Model, adapted from (Ajzen, 1991)**

Main drivers of technology acceptance are the Perceived Ease of Use (PEU) and the Perceived Usefulness (PU) of the new technology, which affect the attitude towards usage and therewith the behavioural intention to use and eventually the actual use.

**Perceived ease of use** is defined as the degree to which an individual perceives the new technology to be usable with minor effort. For instance, in the mobility context this might transfer into having the right technical equipment (smartphone, app, ...) to be able to use a mobility service like Zipcar. The PEU is further enhanced with the perception of external control, which is described as "degree to which an individual believes that organizational and technical resources exist to support the use of a new technology". In the mobility context, we might rather refer to this factor as "external support" which could refer to government support (i.e. subsidies for buying e-cars, integration of carsharing services in public transport, free-parking for e-cars in inner-city, or fast-lane access for carpoolers).

Many adaptations have been done since then, coming to the newest scale, the UTAUT2. UTAUT2 was first proposed by (Venkatesh, Thong, & Xu, 2012) as an extension of Unified Theory of Acceptance and Use of Technology (UTAUT) tailoring it to a consumer use context.

The authors also incorporated three new constructs into it: **hedonic motivation, price value, and habit**. Adaptations of UTAUT2 to investigate acceptance of vehicle automation and similar technologies have shown as a satisfactory framework across times and settings, indication strong validity (Madigan, Louw, Wilbrink, Schieben, & Merat, 2017; Yousafzai, Foxall, & Pallister, 2007a, 2007b).

### 1.3.2 Travel attitudes and behaviour in cities

Empirical work was investigated on how attitudes towards transport modes and technology frame people's willingness to adopt new and more sustainable forms of transport. To do so, a state of the art review was conducted to identify previous investigations on the use of web applications in the context of new and more sustainable forms of transport, and especially of shared mobility.

**APPENDIX 1** presents the research method and the list of 22 relevant studies from the literature review related to empirical work in the field.

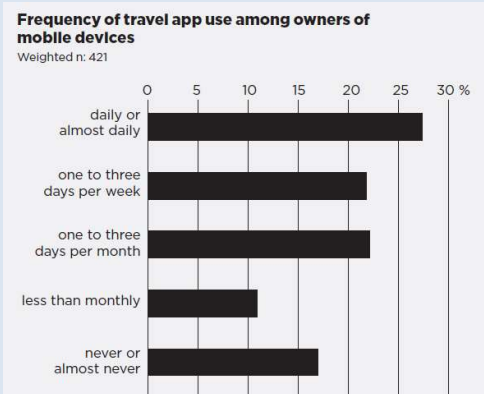
#### A CLOSER LOOK AT SOME OF THE CURRENT ATTITUDES TOWARDS CAR SHARING AND ICT

##### Zoom 1 Attitudes towards carsharing and ICT in Berlin

An in-depth survey was conducted by LSE Cities/InnoZ with 987 respondents in Berlin, to investigate travel behaviour patterns, and behaviours in relation to new urban mobility opportunities, including bike and car sharing, electric cars, cycling and smartphone travel apps.

The study shows that **car travel in Berlin is the most common with 37%, followed by public transport at 30%** and a remarkably high cycling rate at 17%. Walking comes in at 8%.

On the other hand, **availability of cars is relatively high in Berlin**. Households that do not own a car make up 27% of households surveyed and are in the minority. The survey asked non-car owning households what their main reasons for choosing not to own a car were. The most common reasons were 'Cost' and 'No Car Needed' –reported by 53 and 47% respectively – indicating that convenience and budgeting issues seem to be most strongly influencing behaviour. Environmental reasons were cited by 22% of participants and health reasons by 18%. **Car sharing is an increasingly popular option for those who want car access in cities without having to own a vehicle**. Yet only 3.4 % of respondents had at least one car sharing member in the household.



This is low, indicating that there is still a long way to go before car sharing makes a widespread impact on current travel in Berlin.

Most of the respondents who indicated membership, however, joined after 2011; this may hint at the beginning of an upward trend in car sharing uptake albeit on statistically uncertain terms.

**ICT is playing an increasingly important role in travel behaviour in Berlin, particularly in relation to public transport.** According to this study, among smartphone owners, travel apps are used frequently. Daily use was recorded by 28% of participants. A further 22% used travel apps one to three days per week.

<https://lsecities.net/publications/reports/towards-new-urban-mobility/>

## Zoom 2 Attitudes towards carsharing and ICT in London

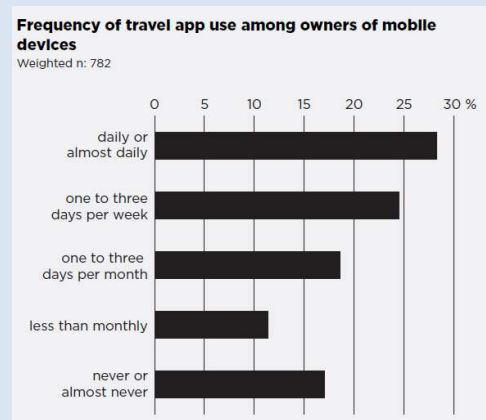
An in-depth survey was conducted by LSE Cities/InnoZ with 1,184 respondents in London, to investigate the travel behaviour patterns, and behaviours in relation to new urban mobility opportunities, including bike and car sharing, electric cars, cycling and smartphone travel apps. The study shows that **the use of public transport in London is particularly high at 46%**. Active travel modes are relatively modest, at 11% for travel on foot and 3.8% for travel by bike.

Nearly four in five respondents (79%) who possess a driver's licence always have a car available to drive. Similarly, **household car ownership is relatively high** in the sample, with 75% of households owning at least one car.

The main results suggested that **owning a vehicle in London is a significant expense for households**; the majority believed that traffic and lack of parking space are burdensome, and around 32% affirmed that they would like to have access to a car without owning it. Moreover, around 30% of car owners agreed that MaaS would help them depend less on their cars, that MaaS would remove the hassles related to owning a car and that they would be **willing to rent their car to others MaaS users**. (Kamargianni, Matyas, Li, & Muscat, 2018).

Only 2.5% of households included a member who was part of a car sharing scheme. The response suggests the majority of those are Zipcar members, considered to be the dominant car sharing company in London.

The **ownership of smartphones is high** among survey participants at 59%. This provides a very large potential user base for mobility services. Travel apps are used frequently by owners of smartphones or other mobile devices (e.g. tablets). Daily travel app use was reported by 28% of survey participants who owned smartphones.



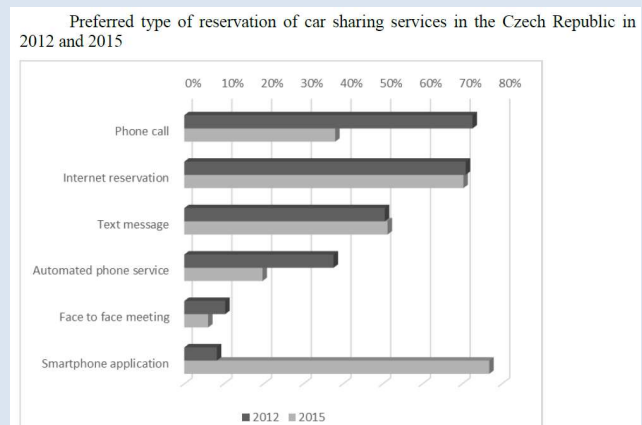
<https://lsecities.net/publications/reports/towards-new-urban-mobility/>

### Zoom 3 The Czech Republic

Two large socio-geographical surveys were conducted by on the territory of the Czech Republic in 2012 and 2015 to capture dramatic changes that are related to changes in attitudes of Czech population towards car sharing.

Key findings include the fact that, thanks to the technological revolution connected with the widespread using of smartphones among population, people's attitudes to car sharing are changing significantly. The share of people who reported that car sharing can be very useful for them and they would certainly use it if it was available in their place of residence, increased from 4.1% to 8.9%.

Moreover, the biggest change in attitude is visible in changing perceptions of car sharing service: while in 2012 people tended to believe that "it is still better to own a car, because the use of car sharing reservation system is not comfortable", in 2015 people are delighted how simple and flexible is using of smartphone booking applications. In addition, the ease of use of car sharing services is appreciated also by people who reported that they need to own car for everyday use. These people would welcome the possibility of short-term rental of cars (which should be easily covered by car sharing) in a location where they spend their holidays.



[\*Changing attitudes towards car sharing: a big chance for urban ecology?\*](#)

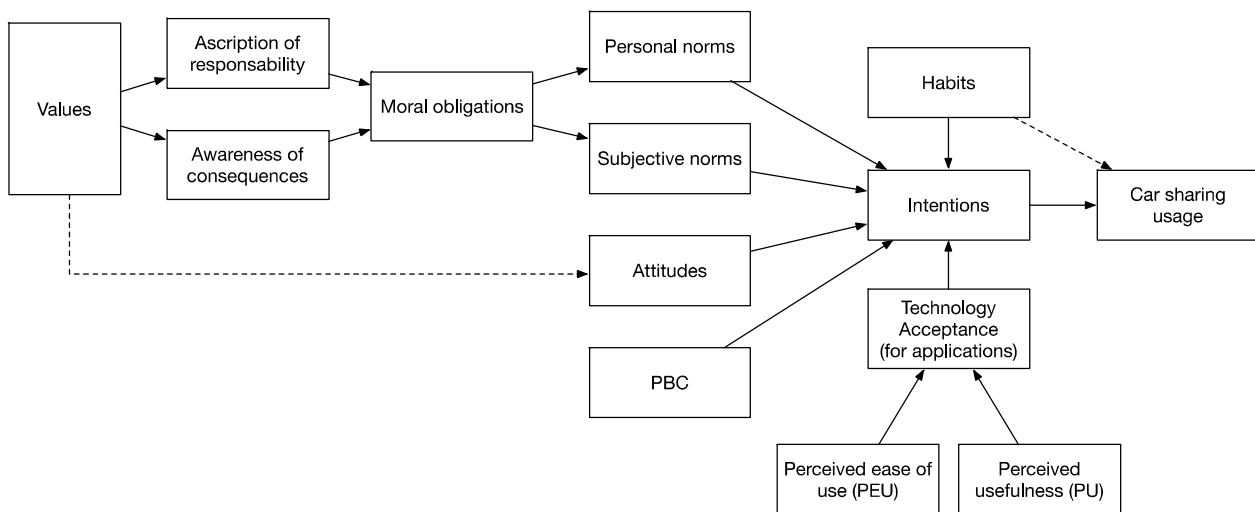
### 1.3.3 Integrated model to predict shared mobility use

A meta-analysis on 58 primary studies identified a total of 15 models to investigate travel mode choice. As mentioned in section 1.3.1, besides intentions, the habits and past behaviour were the main predictors of travel mode choice (Lanzini & Khan, 2017). A diversity of operationalisations in the area to measure travel behaviour showed as a problematic aspect, indicating a need for a more integrated model and systematized measurements.

Keeping the rationale of the family of models derived from the TRA, we propose an integrated model for shared mobility (Figure 4). The model focus on the increased demand for technology acceptance in a transportation scenario with constant changes. We argue that **habits have a strong and even direct effect on daily commuting while the transportation scenario imposes new demands for technology acceptance**, such as the use of web applications. What is now demanded by transport innovations such as shared mobility, MaaS and car sharing is that **users start to plan their trips according to the most efficient way to go from A to B**, maximizing use of resources and increasing accessibility. Those innovations will reshape, over the time, values, norms and attitudes.



The model proposes a convergence of TPB with Habits (commuting habits and habits of planning trips), TAM for use web/apps/social media and Moral obligations regarding environment impact (awareness of consequences and need of change). In this framework, personal norms and subjective norms are predicted by moral obligations which are predicted by values. Strong pro-environmental moral obligations would increase pro-environmental norms to use sustainable transportation. **Along with norms, greater the attitudes and PBC, the higher would be the behavioural intention.** Correlated with PBC, technology acceptance, such as **use of applications to book a car in car sharing, is another direct predictor of behaviour intention.** Habits (commuting habits and habits of planning trips) will predict intentions as well as the use car sharing. **The stronger the habit, the stronger is the direct effect on the final behaviour.**



**Figure 4: Integrated Model for Shared Mobility (UGOT)**

## 2 Exploring the relationship between car sharing diffusion, socioeconomic factors and web 2.0 indicators

With the recent growth of car sharing in Europe, car sharing profile users have been subject to an important number of academic studies. Indeed, there is a growing body of literature that identifies them as **younger** (Clewlow & Mishra, 2017; Dias et al., 2017; Habib, Morency, Islam, & Grasset, 2012; Kopp, Gerike, & Axhausen, 2013; Martin & Shaheen, 2011; Martin, Shaheen, & Lidicker, 2010; Morency, Nurul Habib, Grasset, & Islam, 2012), with **higher employment rates** (Clewlow & Mishra, 2017; Dias et al., 2017), **educated** (Becker, Loder, Schmid, & Axhausen, 2017; Clewlow, 2016; Clewlow & Mishra, 2017; Coll, Vandersmissen, & Thériault, 2014; Dias et al., 2017; Kopp et al., 2013; Kopp, Gerike, & Axhausen, 2015; Martin et al., 2010), **with higher income** (Clewlow, 2016; Clewlow & Mishra, 2017; Dias et al., 2017; Efthymiou & Antoniou, 2016; Kopp et al., 2013) **but fewer owned cars** than the average (Becker et al., 2017; Clewlow, 2016; Dias et al., 2017; Efthymiou & Antoniou, 2016; Huwer, 2004; Martin et al., 2010), and **living in denser urban areas** (Clewlow & Mishra, 2017; Dias et al., 2017; Kopp et al., 2013, 2015).

These studies have been very useful for defining profiles of early adopters of this emerging service. However, in general, they are largely based on the one-off observation of a sample of individuals living in a given area. Consequently, these findings may not necessarily give insights of the evolving trends in the sector and the factors shaping these trends. Additionally, studies conducted in a single area could lack general validity, since external variables might not be well contextualised.

**With this in mind, the STARS partners set out to better understand the intertwined relationships among the different variables at stake, including a better understanding of how car sharing adoption trends are influenced by the evolution of sociodemographic characteristics, mobility behaviours and use of web 2.0 services.**

To do so, we undertook a complementary approach in which we analysed aggregated statistics for a time series in a given area, or the same statistics in different countries and cities. The choice of cities and countries was based on data availability. Car sharing data has been gathered through different sources, including car sharing operators' websites, newspaper, annual surveys for the different car sharing systems, and statistical data at national and city level. It is important to note that during the data collection process, it was not always understandable if in data numbers of P2P car sharing were included (in terms of car users and car owners). As a result, the available data was grouped in two main variables:

- ★ **Number of car sharing members:** it indicates the aggregate number of members in a certain city or country, without any distinction about the kind of service. In some cases, it was possible to find such more disaggregated information (e.g. number of members of car sharing station-based services or free-floating) but neither on an annual basis and nor for each country. Another limitation is due to the fact that it was not possible to find the number of unique members,



which means that maybe some members are counted more than once since they are customer of more than one service.

- ★ **Number of car sharing vehicles:** it indicates the aggregate number of vehicles in a certain city or country. In some data sources it was not specified if the amount includes VANS<sup>25</sup> as well as cars.

**APPENDIX 2** presents the different sources used and details how the different sources have been collated to come up with time series. As described in **APPENDIX 2**, two types of plots were selected and used to visualise possible trends: longitudinal and cross-sectional plots.

## 2.1 Relationships with socioeconomic trends

Population in many EU countries is ageing and shrinking, a trend that is partially compensated by immigration that has however a widely differentiated impact across regions and areas in Europe. Although the diffusion of car sharing is a niche phenomenon compared to the structural demographic changes of the population, at the outset it is however interesting to put into relationship related trends in different countries and cities, subject to data availability. Given the characterisation of car sharing users according to previous studies that was recalled in the preceding paragraph, in the following subheads we particularly focus on the available annual time series of the following four variables:

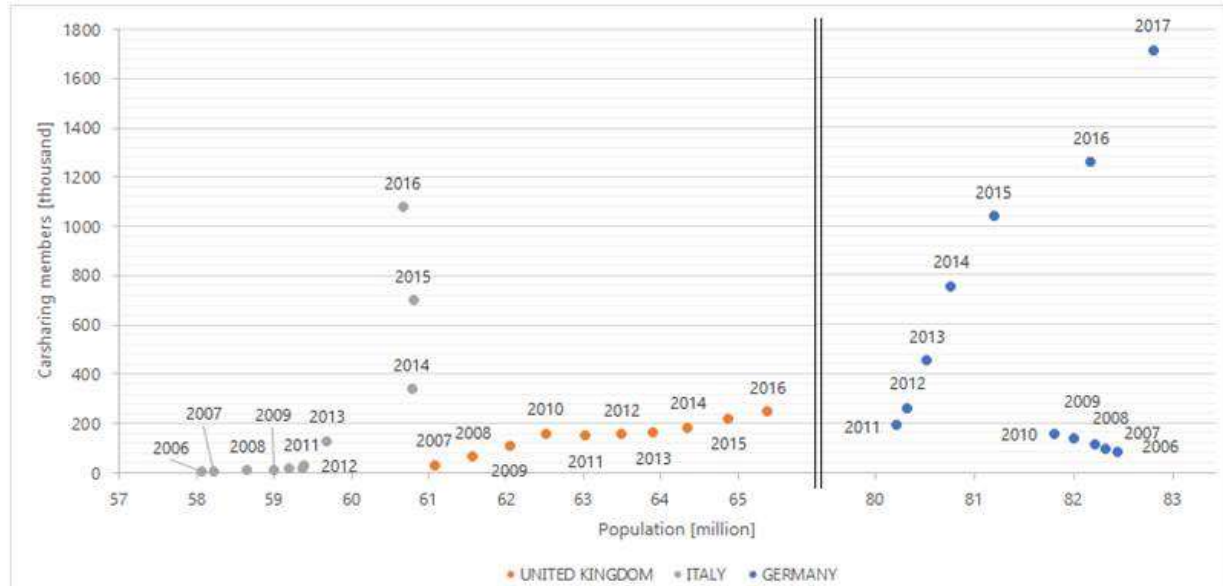
- ★ **General population:** number of inhabitants in each country ([Eurostat](#))
- ★ **Population within the 15-24 and 25-49 age brackets** ([Eurostat](#))
- ★ **Highly educated population:** number of inhabitants with short-cycle tertiary education (level 5), bachelor (level 6), master (level 7) and doctoral (level 8) according to the International Standard Classification of Education 2011 (ISCED11) ([Eurostat](#)).
- ★ **Income:** the adjusted gross disposable income of households per capita is used; it reflects the purchasing power of households and their ability to invest in goods and services or save for the future, by accounting for taxes and social contributions and monetary in-kind social benefits ([Eurostat](#)).

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<sup>25</sup> A van is a type of road vehicle used for transporting goods or people

## 2.1.1 General population

Figure 5 presents the relation between car sharing members and population over the last ten years, for three different countries: United Kingdom (UK), Germany and Italy. As may be seen, trends are very different.

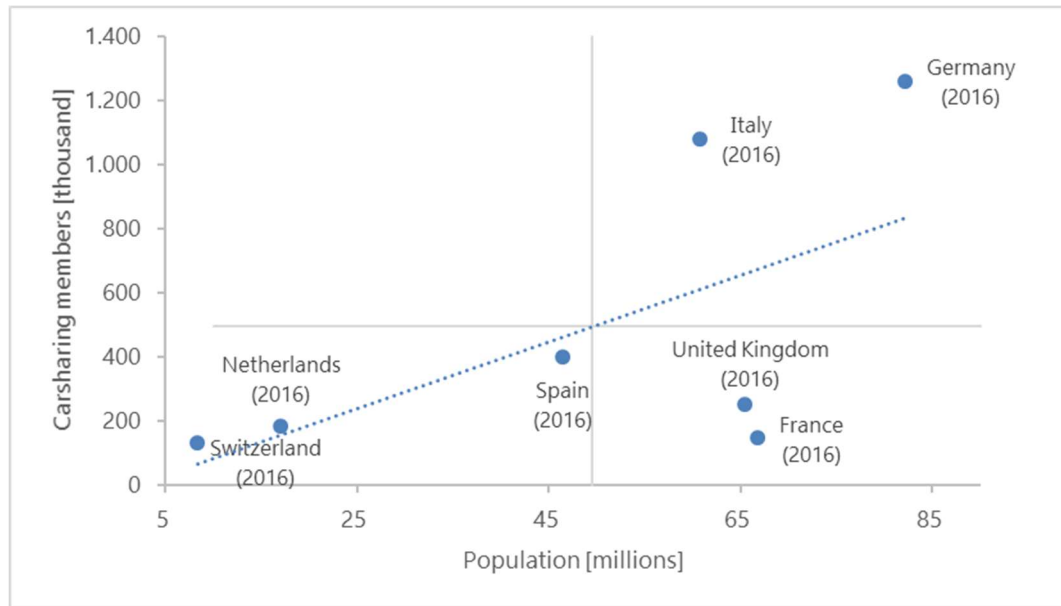


**Figure 5: Population in Italy, UK and Germany - Car sharing members**

Car sharing members in UK had a steady increase over the last decade that proportionally seemed to match well that of the general population, with the only exception of the economic crisis in years 2008-2010. Excluding such period, a linear relationship seems evident from the data.

The situation is completely different in Germany and Italy. The population of Germany seemed to shrink until 2011 while car sharing had a relatively slow diffusion. In this case, the diffusion of car sharing is not so much connected to the population dynamics. In Italy, car sharing diffusion is a more recent phenomenon that is again not connected with population trends. In both countries the sharp increase after 2012 is due to the market entry and expansion of free-floating car sharing services.

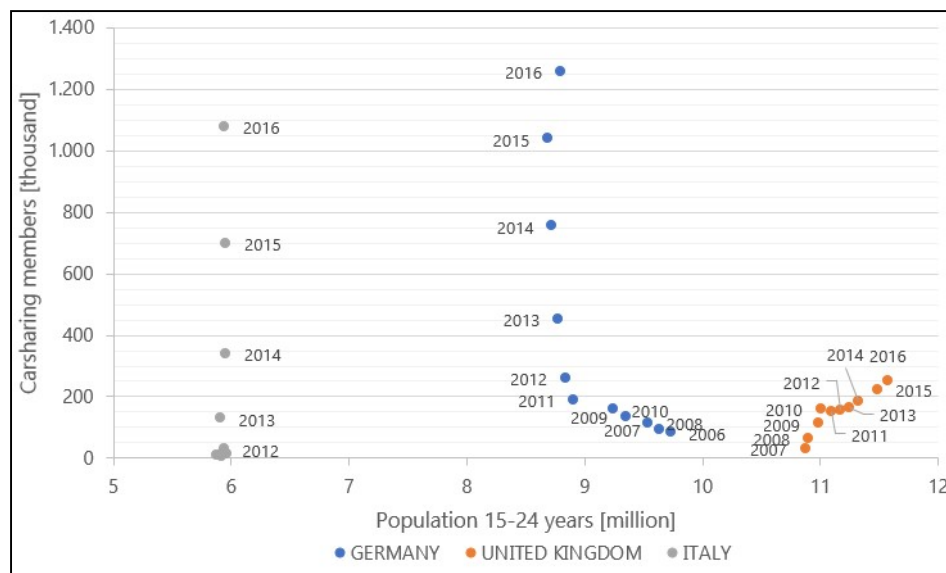
Figure 6 presents a picture of car sharing membership in 2016 in six different countries. Countries like Italy and Germany, depicted in the upper right quadrant, show a high diffusion of car sharing, whereas countries like UK and France show that although that the inclusion of the car sharing is quite low even when the population reach high values. Spain was somewhat halfway in 2016.



**Figure 6: Population - Car sharing members (Countries 2016)**

## 2.1.2 Younger population segments

Two younger population segments are studied in this subsection, which seem more related with the car sharing user profile mentioned before. Actually, the first segment is not completely useful because of the presence of population surely without driving license (those who are under 18 years), but such definitions of segments are the one available in the above reported statistics.



**Figure 7: Population from 15 to 24 years - Car sharing members**

Figure 7 highlights similar trends to the ones observed in Figure 5. In UK, the young segment of car sharing members had a fast increase during the period 2007-2010 and a steady increase over the last 4 years. This seems to match well that of the population between 15-24 years.

Once again in Italy and Germany the situation is different: both countries are having a very strong increase of car sharing members while the population between 15-24 years has different growth patterns. During the last decade, the younger population segment in Italy is almost stable (around 6

million), while in Germany a shrinking of young people seemed in a linear relation with the car sharing membership until 2011. After 2011, the number of car sharing members in Germany increased dramatically, compared to slighter changing in the young population segment.

The population segment between 25 and 49 years is investigated in Figure 8. As may be seen, the diffusion of car sharing is not aligned with younger population dynamics. Until 2011, this population segment in Germany seemed to follow the trend of the general population, while car sharing after 2011 strongly increased in terms of members. On the other hand, in Italy, it was after 2014, when car sharing members notably increased for the above-mentioned market reasons related to diffusion of free floating services.

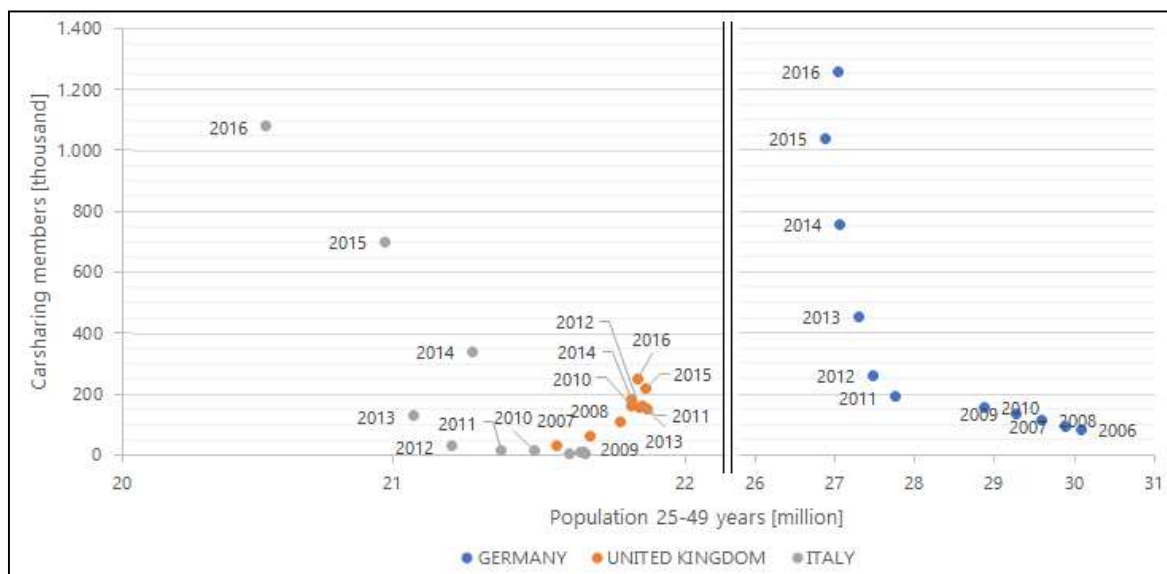
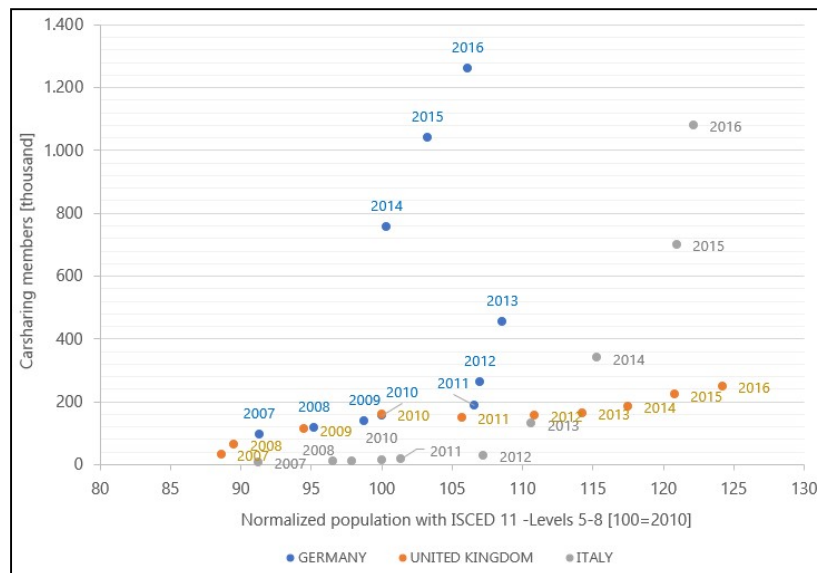


Figure 8: Population from 25 to 49 years - Car sharing members

### 2.1.3 Education levels

As highlighted previously, the level of education seems to influence car sharing membership levels. It is important however not to assume that this happens in every country. According to our study, **Figure 9** the increase of car sharing members in UK from 2012 seem to match well that of the population with an ISCED11 level between 5 and 8 (see the introductory text of paragraph 2.1). Similarly, a linear relationship seems evident from the Germany data, where from 2014 a strong increase of car sharing members is supported by a steady growth of well-educated people. In contrast, car sharing diffusion in Italy is not well explained by the educational trend, so that the observed trends of the two variables are mainly due to different factors, rather than to the effect of the latter over the former.



**Figure 9: Educational level – Car sharing members**

## 2.1.4 Income

The level of income was also highlighted as a factor to influence car sharing membership levels. However, as may be seen in figure below, the increase in income has been more or less steady in Germany, while the corresponding increase in car sharing membership is much more substantial in the last four years, as already mentioned. Concerning the UK, we witness a steady increase in car sharing membership both in periods where per capita income shrunk (2004-2006) and when they increased (2010-2013). Moreover, car sharing membership in Italy raised only in more recent years, as already mentioned, while until 2009 this figure was rather flat regardless the fluctuations in per capita disposable income. Thus, car sharing adoption patterns does not seem to be related to economic development trends: different social perspectives needs to be explored. Figure 11 shows which countries among the considered five has a relatively higher number of car sharing members (Italy and Germany), albeit the former has relatively lower mean incomes and the latter is in the opposite situation.

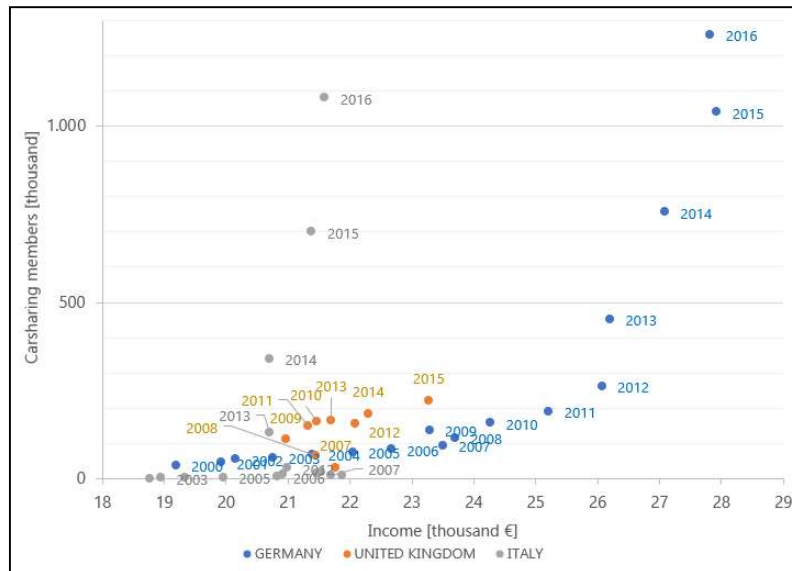


Figure 10: Income per capita – Car sharing members

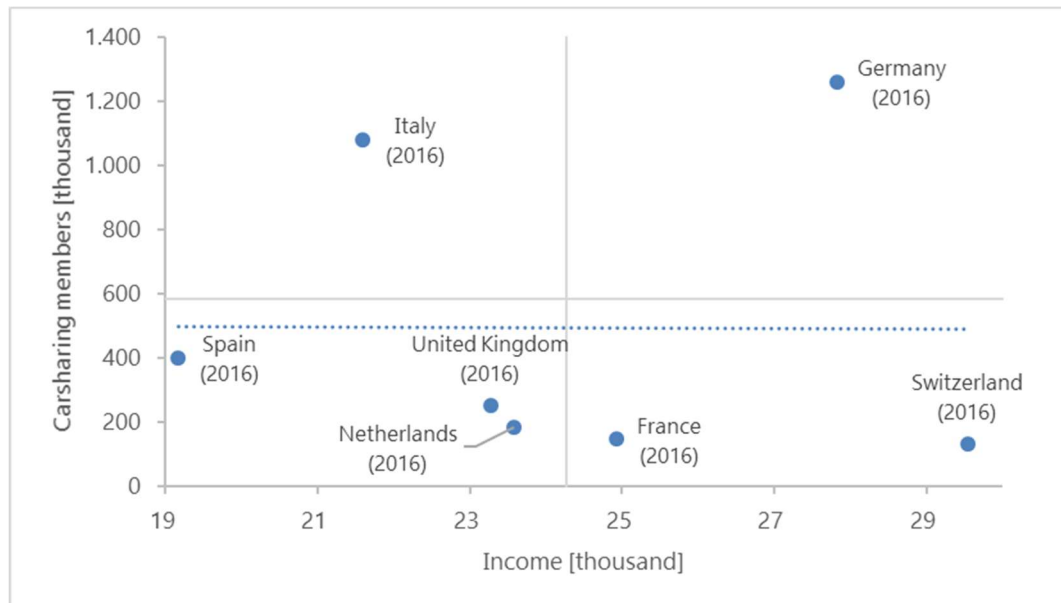


Figure 11: Income per capita – Car sharing members (Countries 2016)

## 2.2 Relationships with car ownership and mobility trends

In the last decade mobility trends in many EU countries are changing: as a consequence of the world economic crisis, the mobility demand has suffered a contraction, reflected in the reduction of the average number of daily trips which shrank in the whole Europe with more remarkable rates in certain countries (ISFORT, 2016). The number of new cars registration has suffered a reduction and the passenger car production reached a pre-crisis level only in the latest year (ACEA, 2016).

Although the diffusion of car sharing is a niche phenomenon compared to those general changes, at the outset it is however interesting to put into relationship related trends in different countries and cities, subject to data availability. Car sharing is rapidly expanding, and the goal of the below

analysis is to check if any relationship might already be spotted at the aggregate level, or this is likely to become evident only in a more or less near future. In the following subheads we particularly focus on the available annual time series of the following variables:

- ★ **Car ownership:** it represents the number of passenger cars per 1000 inhabitants (source Eurostat: [http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road\\_eqs\\_carhab&lang=en](http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_carhab&lang=en) )
- ★ **First registration passenger cars:** it is the number of new cars registered every year (source Key Transport Statistics 2015 International Transport forum: <https://www.itf-oecd.org> )
- ★ **Number of trips:** it is the average number of daily trips done in a week day independent from the transport mean (sources: <http://www.isfort.it/> , <https://www.gov.uk/government/collections/transport-statistics-great-britain> )
- ★ **Modal split:** it represents how the number of trips is divided by the different modes such as car, public transport, bike and walk (sources: <http://www.epomm.eu/>; <http://www.isfort.it/>; <https://www.gov.uk/government/collections/transport-statistics-great-britain> )

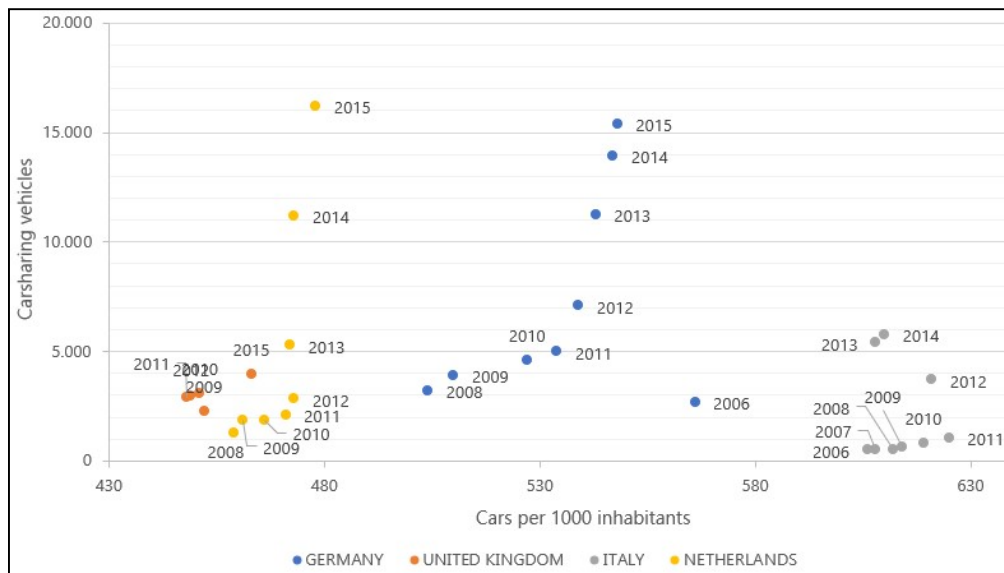
## 2.2.1 Car ownership

In Figure 10 it is reported a scatterplot representing the number of cars per 1000 inhabitants (car ownership) and the diffusion of car sharing in terms of fleet size. Considering trends over the last decade of the four countries (namely, Germany, Italy, Netherlands and the UK), different situations can be seen.

In United Kingdom it is evident the almost steady state of the car ownership as well as the number of car sharing vehicles. In Italy, country which has the highest car ownership rate among those reported, until the 2011 the growth of both variables was quite linear (the dimension of the phenomena was small, with 1000 shared cars over almost 40 million cars). In 2012 and 2013, the number of car sharing vehicles increased remarkably combined with a reduction of car ownership, while in 2014 we observe the same trend of the previous years. Meanwhile in Germany a noticeable increase in the car sharing vehicles is supported with a slight increase of number of cars owned.

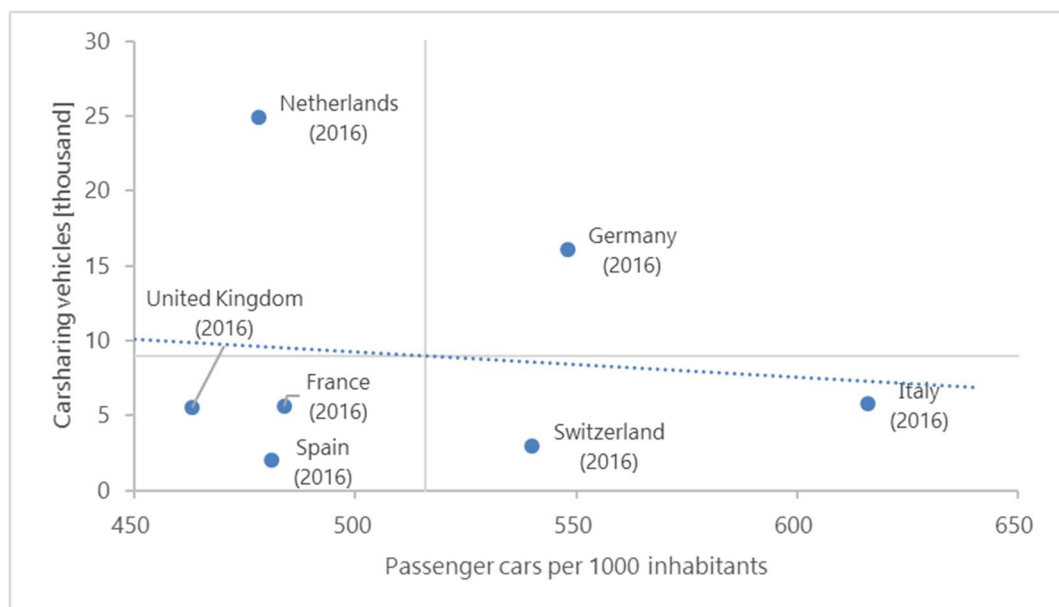
The Netherlands case is quite singular because of the presence of P2P car sharing vehicles, which can explain the highest number of shared cars. Thus, car sharing adoption patterns seem to be not related to car ownership development trends.





**Figure 12: Car ownership – Car sharing vehicles<sup>26</sup>**

Figure 13 below depicts a chart of car sharing fleet sizes in 2016 in different countries as a function of motorisation rates. Under the interpolation line, there are countries where the diffusion of car sharing fleet is relatively low, on the contrary in the upper part it is showed where car sharing is more diffused. Surprisingly in Netherlands the car sharing diffusion seems stronger, but this might be due to the inclusion of P2P car shares, as mentioned before, to achieve consistency with the other plots.



**Figure 13: Car ownership – Car sharing vehicles (Countries 2016)**

<sup>26</sup> Car sharing vehicles in Netherlands are inclusive of P2P vehicles, while for the other countries this figure is not mentioned.

The comparison of Figure 13 and Figure 6 gives some interesting insights. More specifically, the Italian market penetration of car sharing seems relatively higher if one considers the potential market dimension (number of car sharing members related to population), but not so high considering the actual service dimension in terms of number of shared cars related to motorization levels. Several different reasons might explain these findings, including an inflation in the number of inactive car sharing subscribers in this country due to specific marketing policies, a higher than average intensity of use of shared cars due to the service operational characteristics or the much higher number of privately owned passenger cars.

## 2.2.2 First registration passenger cars

Observing the scatterplot reported in Figure 14, new car registrations are again growing in Germany after a sharp drop during the economic crisis. In those same years (2011-2013) there was a strong increment of car sharing vehicles, probably due to roll-out of two major free-floating car sharing operators. In Italy new car registration is shrinking while the car sharing vehicles are slightly increasing, in Netherlands the new cars seem to have a static trend while the number of shared vehicles is exploding.

Although there is not a functional relationship between the two variables that is valid across different countries, it is interesting to note that within each country (with the exception of UK) the biggest annual increase in the number of car sharing vehicles is often associated to a decreasing number of new car registrations: in 2014 and 2016 in the Netherlands, in 2012 and 2013 in both Italy and Germany.

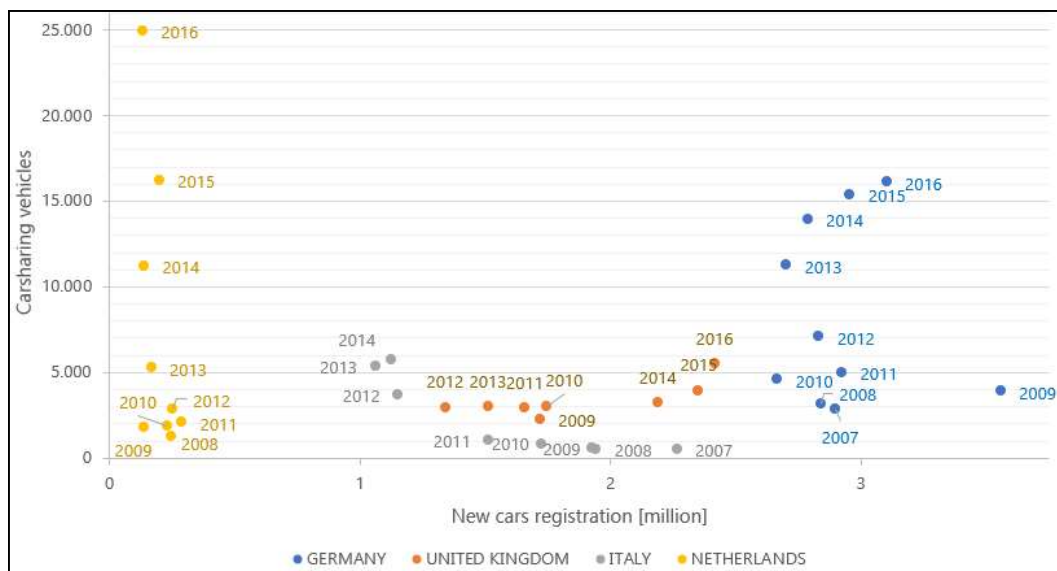


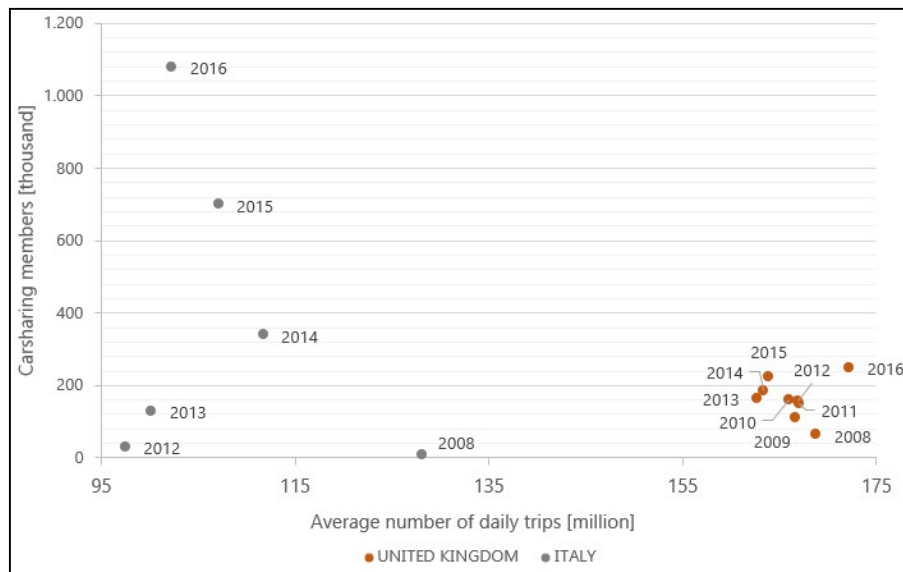
Figure 14: New cars registration – Car sharing vehicles

### 2.2.3 Number of trips

The average amount of daily trips does not seem to have a functional relationship on car sharing membership levels, according to Figure 16.

As mentioned in the subsection above, we can observe in Italy and United Kingdom a reduction of trips compared to the 2008 level: only in 2016 in UK the mobility trend overtake the 2008 situation. The most interesting finding is however gathered if one considers the fact that the time series in the UK portrays a relatively static situation, where both variables have relatively minor annual variations. Italy is in the opposite situation, with large variations in mobility level that are contextual to a strong increase in car sharing membership. Mobility habits of Italians were much more overhauled than in other European countries due to the economic crisis, and one interesting research question is to understand to which extent breaking such habits might have induced a stronger propensity to adopt car sharing.

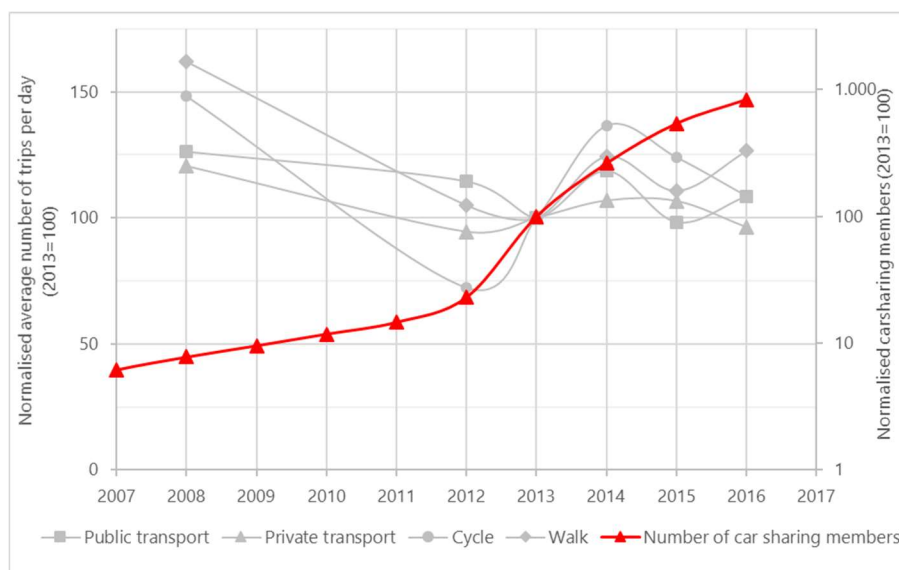
Unfortunately a complete collection of historical data related to the trips done by car sharing is not available, but just some spot information. For example in Italy in 2002 were registered 667 rents of shared cars in the whole year; in 2016 the number of carsharing ride was about 6.3 million. As already mentioned in absolute terms the increase in the use is impressive, but compared to the average number of daily trips it clearly shows how car sharing is a niche phenomenon.



**Figure 15: Daily trips – Car sharing members**

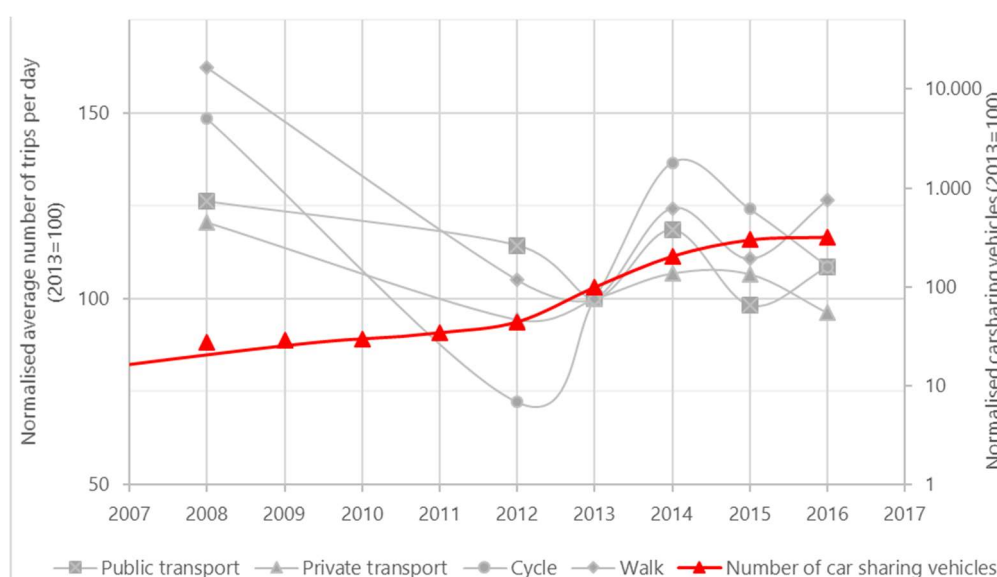
## 2.2.4 Modal split

Historical trends related to the modal split and the *number of car sharing members* in Italy are showed in Figure 16: all information is normalised to the values registered in 2013 (2013 is 100) since the two variables have different orders of magnitude. Figure 17 shows the same kind of representation but using the number of car sharing members instead of the *number of vehicles*.



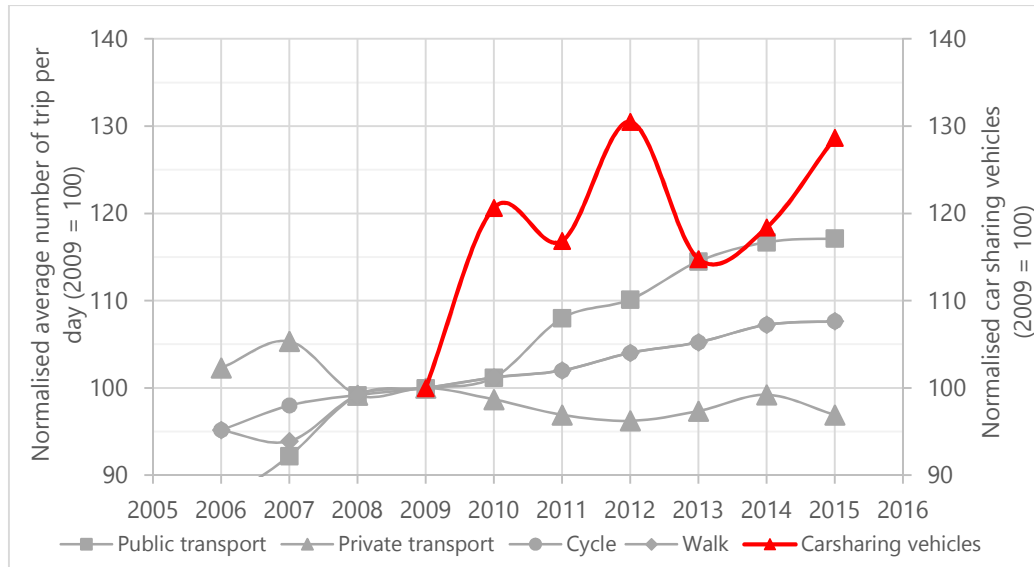
**Figure 16: Trip-based modal split in Italy – Car sharing members**

Once again no relationship between car sharing adoption patterns and modal split development trends is observed: before 2012 both car sharing trends were increasing steadily while the trips done by the different modes of transport were reducing; between 2012 and 2014, the number of trips done by bike had a similar growth pattern of the car sharing vehicles and members, while after 2014 car sharing kept growing exponentially while all the other modes had some fluctuations.

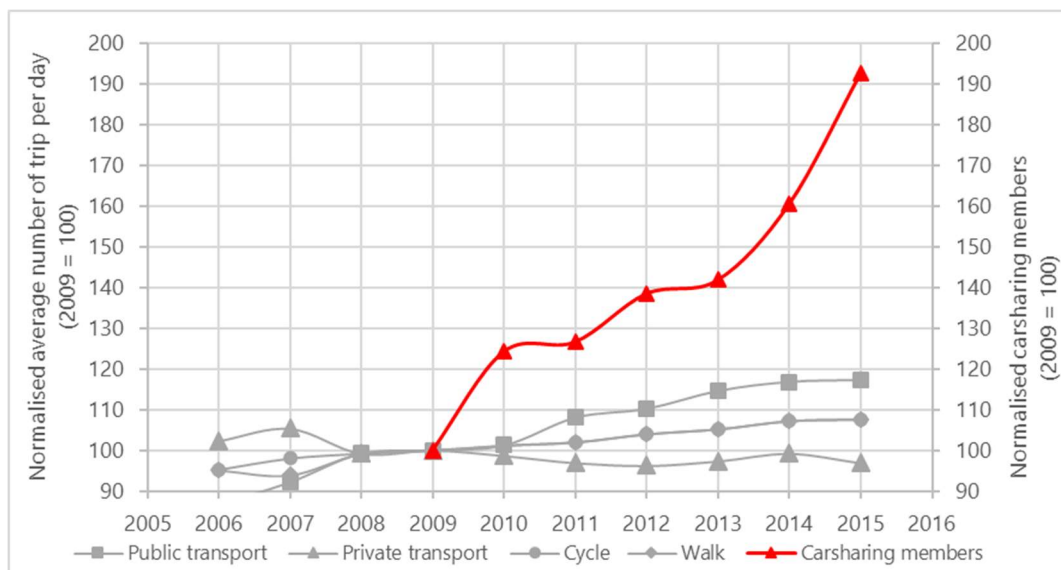


**Figure 17: Trip-based modal split in Italy - Car sharing vehicles**

Since car sharing is a niche phenomenon and more related to the city level, this factor has also been studied at local level. In particular, historical trends related to the modal split and the *number of car sharing vehicles* are investigated in London (see Figure 18). Both series are normalised to the values registered in 2009 (2009 is 100). Figure 19 shows the same kind of representation but using the number of car sharing members instead of the number of vehicles.



**Figure 18: Trip-based modal split in London - Car sharing vehicles**



**Figure 19: Trip-based modal split in London - Car sharing members**

Concerning the normalised average amount of daily trips reported in Figure 18 and Figure 19, trends in the use of the different means are more steady over the whole observation period, where both public transport and bikes are increasing while private transport is generally either stable or decreasing.

It is interesting to note that relatively smaller annual increases in the number of trips done by public transport and in the number of car sharing vehicles are associated with larger increases in car sharing members (like in 2010, 2012, 2014 and 2015 over the previous years), and vice-versa, although no conclusive findings can be drawn from annual fluctuations that might be due to different reasons.

## 2.3 Relationships with population at the city level

In this section, the relationship between car sharing is studied against population at city level. To do so, we have split the investigation into two different groups: cities with less than 500.000 inhabitants and cities with more than 500.000 inhabitants.

### 2.3.1 Cities with less than 500,000 inhabitants

Figure 20 presents a snapshot of car sharing members in 2016-2017 for 14 different cities. Of less than 500,000 inhabitants. As may be seen, Bordeaux and Gent have the strongest car sharing diffusion in terms of numbers of members. Regarding the number of car sharing vehicles available in the city, Gent, Firenze and Karlsruhe are the cities with largest car sharing fleets (see Figure 21). These results support the assessment of use cases presented in Chapter 3, in which both the involvement of city authorities and the number of car sharing stations are seen to influence the successful implementation of car sharing services in a city.

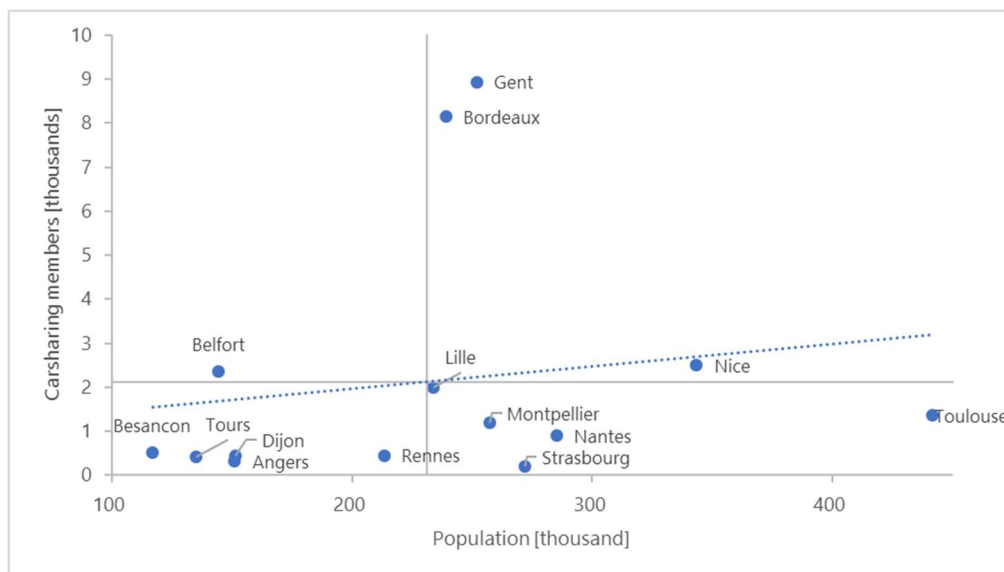
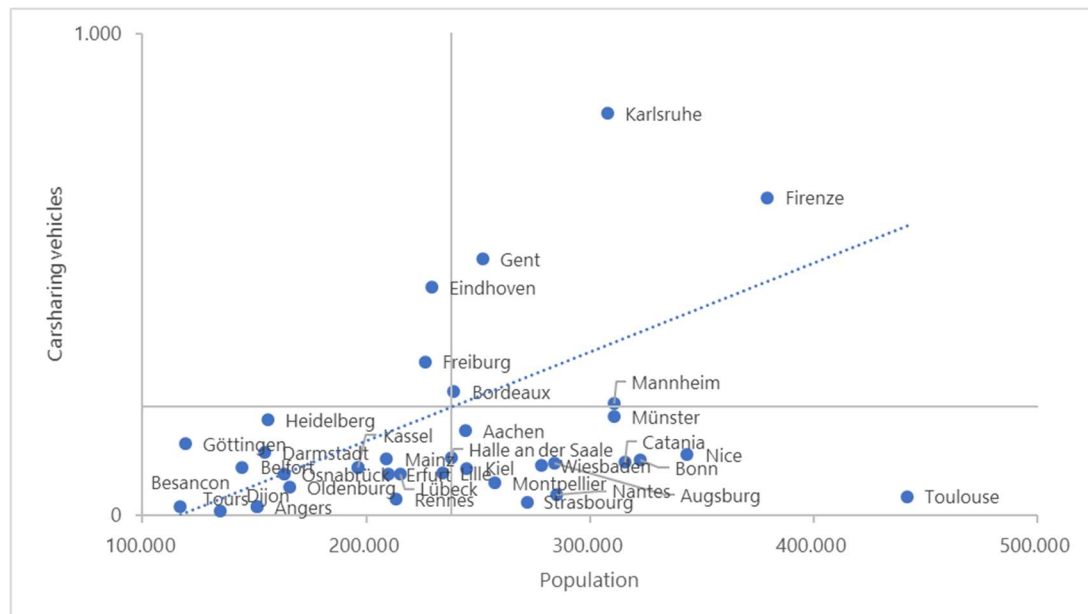


Figure 20: Population – Car sharing members (cities<500k inhabitants)

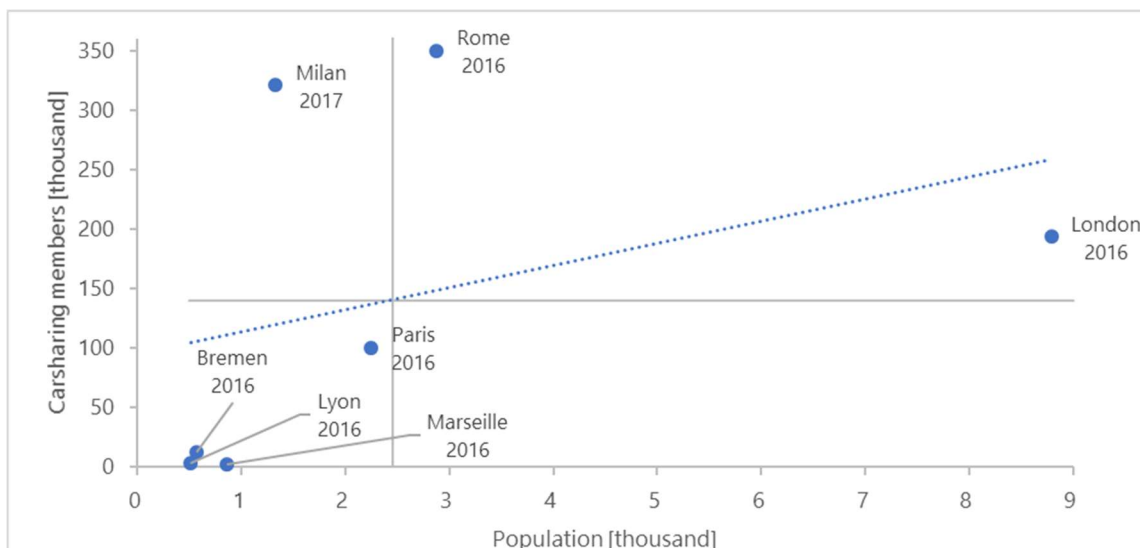


**Figure 21: Population – Car sharing vehicles (cities<500k inhabitants)**

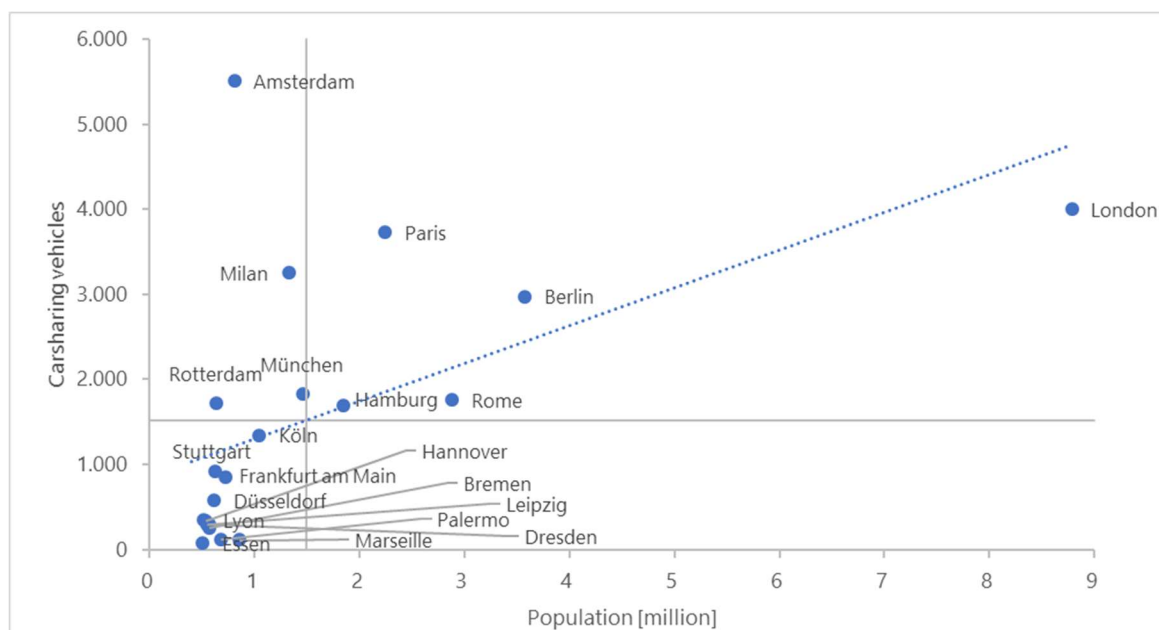
### 2.3.2 Cities with more than 500,000 inhabitants

Figure 22 presents a snapshot of car sharing members in 2016-2017 for 7 different cities of more than 500,000 inhabitants. Figure 23 considers car sharing vehicles instead of membership. The comparison of Figure 22 and Figure 23 gives some interesting insights. More specifically, the city of Rome seems to have a strong car sharing diffusion in terms of number of members, but the number of car sharing vehicles is under the interpolation line. It seems that car sharing services in Rome attract more members compared to other cities with a smaller number of cars. On the other hand, in the city of Paris the situation is the opposite: the diffusion of the car sharing in terms of members is relatively low despite the relatively large number of available vehicles. Clearly this finding should not necessarily be interpreted as an indication of the fact that the systems in one city are better than in another. Site-specific conditions should be considered for a fair assessment, including the temporal interval since the beginning of the service deployment and the performances of potentially competing travel modes such as public transport.





**Figure 22: Population – Car sharing members (cities>500k inhabitants)**



**Figure 23: Population – Car sharing vehicles (cities>500k inhabitants)**

## 2.4 Relationship with Web 2.0 indicators

In contemporary Western societies, internet and online applications are omnipresent. The analyses in the STARS-research concerning the state of the art of car sharing in Europe (Deliverable 2.1) has shown this is also the case for car sharing in Europe. Every European car sharing service, but one, allows or even obliges its customers to book a shared car via an online platform (website or mobile application). It became also clear that the cars of one organisation in three can only be opened with a mobile application. Nowadays, the car sharing sector fully embraced the online evolution. In this section we will verify if a link can be found between car sharing and the use of online, Web 2.0 services.

In order to do so, three indicating variables have been detected. These variables come from the annual '[European Union Survey on ICT usage in households and by individuals](#)', carried out by Eurostat. For years, the same questions have been asked in all European countries, which makes it a very suitable data source for longitudinal and comparative research.

Respondents were asked to indicate whether they used internet for a list of activities in the last 3 months. Three of those activities are interesting in the light of this research:

- Participating in social networks
- Internet banking
- Using services related to travel or travel related accommodation

In the analyses below, the number of car sharing vehicles was chosen as the indicator of the level of car sharing in the countries under research. Mainly because more longitudinal data is available for this parameter.

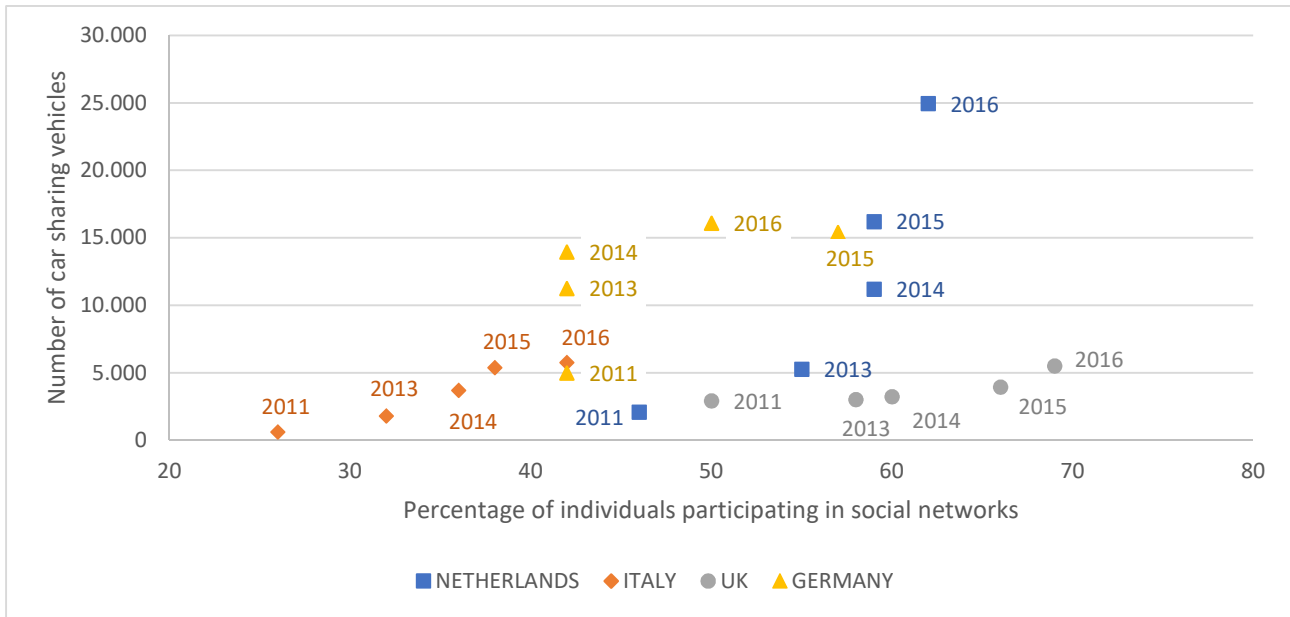
### 2.4.1 Participating in social networks

First, the link between car sharing and the participation in social networks was explored. Respondents were asked whether they used internet to participate in social networks<sup>27</sup>, in the last 3 months. In 2016 on average 52% of the European citizens used internet to participate in social networks, in 2011 this was only 38%. Since we have been gathering longitudinal information on car sharing in Germany, Italy, the UK and the Netherlands, these data were linked to the respective levels of social network participation in that countries.

Except for Germany, the participation level in online social networks increases year after year (Figure 24). In Italy these levels are among the lowest in Europe (2016: 42%), while the social network activity in the UK is rather high (2016: 69%). In all four countries, the number of shared cars is rising through time. While the last half a decade the number of shared cars grew steadily in Italy and in the UK, the car sharing market in Germany and the Netherlands was moving up a gear.

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<sup>27</sup> For example: creating user profile, posting messages or other contributions to facebook, twitter, etc.



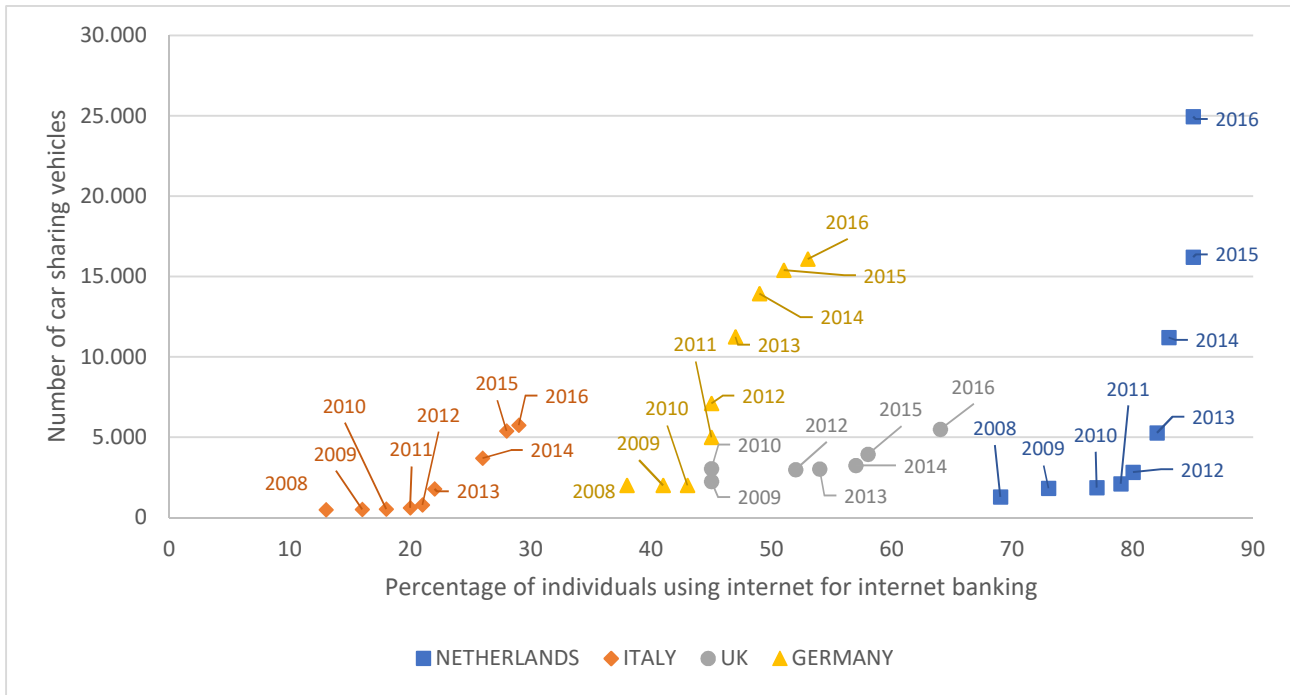
**Figure 24: Social networks – Car sharing vehicles**

The correlation analyses between both variables show a good relationship. Only in Germany no clear link between both variables can be detected. In Italy this link is statistically quite strong. For every increase in the participation level in social networks, an increase in the number of shared cars can be seen. Whether the participation level (independent variable) has a direct impact on the growth of car sharing, and more specifically on the number of shared cars (dependent variable), can't be concluded from this analysis. There might be other related variables influencing on this relationship too.

## 2.4.2 Internet banking

The second indicator is the level of individuals using the internet to manage their financial affairs. Assuming that a lot of shared cars are booked online, some knowledge about or experience with online banking can make the payment process easier and faster.

Again four clusters, one for each country, can be distinguished in Figure 25. In 2008, 70% of the individuals in the Netherlands arranged its bank affairs online. Almost a decade later more than eight out of ten Dutch people are using online banking applications. In Italy, even in 2016, only 29% of the individuals is familiar with internet banking services. The gap between both countries is huge and Germany and the UK are in between.



**Figure 25: Internet banking – Car sharing vehicles**

Through time, both variables displayed in Figure 25 have been increasing in all four countries. In the UK, Italy and Germany, one can find a linear relation between both variables. In the Netherlands it tends more to an exponential relation, mainly because the number of shared cars increased strongly since 2013. Overall it is clear that both the number of individuals using online banking services and the number of shared cars are increasing quite simultaneously in three out of four countries.

### 2.4.3 Using internet for travel services

The last indicator, the percentage of individuals using online services related to travel or travel related accommodations, is taken into account because of the link with car sharing and mobility. If a large share of people is using internet to look for travel solutions, this might be a fertile soil for car sharing schemes. The analyses show a more diffuse picture than the ones before. While Italian citizens are not using internet services a lot to travel (only 27% in 2016), Dutch, German and British people are almost on the same level (about 50% in 2016).

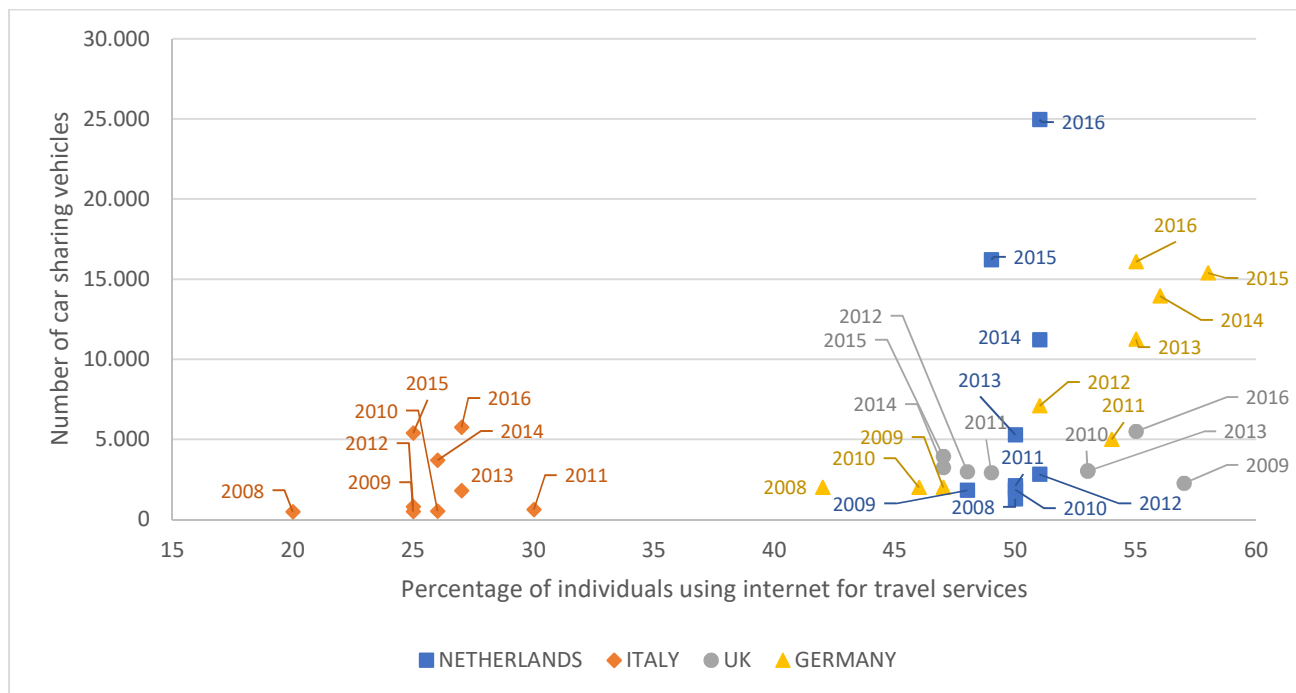


Figure 26: Travel services – Car sharing vehicles

It is hard to detect a trend between both variables. The scatter plots for Italy and the UK show no relation at all. This is largely due to the fact that, in these countries, the percentage of people using online travel services is not (only) increasing in time. Only in Germany one could determine a link between the increasing use of online travel services and the rising number of shared cars.

We might conclude that both the car sharing market and online (Web 2.0) services have experienced significant growth in Europe in recent years. However, it is questionable to what extent the technological evolution, and more specifically the online applications, have already contributed to the growth of car sharing in Europe. We cannot make any statement about this on the basis of our research.

### 3 Use Cases

Three use cases were carried out for this report with the objective of studying the main drivers, barriers and KPI's to deploy car sharing in urban areas. In Paris, Autolib was chosen as an example of a public electrical car fleet that operates as free floating with pool stations. In Bremen, Cambio provides a successful example of a round trip station-based car sharing operator that counts with the continuous support of the local government. And in Barcelona, Drivy offers an example of peer-to-peer car sharing start up that chose Barcelona as one of its internationalisation destination.



**Figure 27: The three case studies**

The methodology undertaken to conduct the three case studies is laid out in Figure 28 and detailed below. As may be seen, in combining data from literature analysis and expert interviews, a multi-level perspective was used to help analyze both the internal and external factors shaping the car sharing deployment in urban areas.



1

**Analysis of internal factors:** The first stage aimed at analyzing the internal factors influencing the development of a car sharing services, namely the elements related to their business model and figures related to the business performance. To do so, desk research was conducted and complemented with an interview to the car sharing operator. The Business Model Canvas tool (Osterwalder & Pigneur, 2010) was then used to analyse and present the results.

2

**Analysis of external factors:** The objective in this second stage was to analyse the technical, political, environmental, and socio-economic factors driving or challenging the development of car sharing services in a specific city. To do so, desktop research was conducted and complemented with an interview to the transportation planner of the specific city. An adaptation of the PESTEL tool (Pestel Analysis, 2015) was then used to analyse and present the results.

3

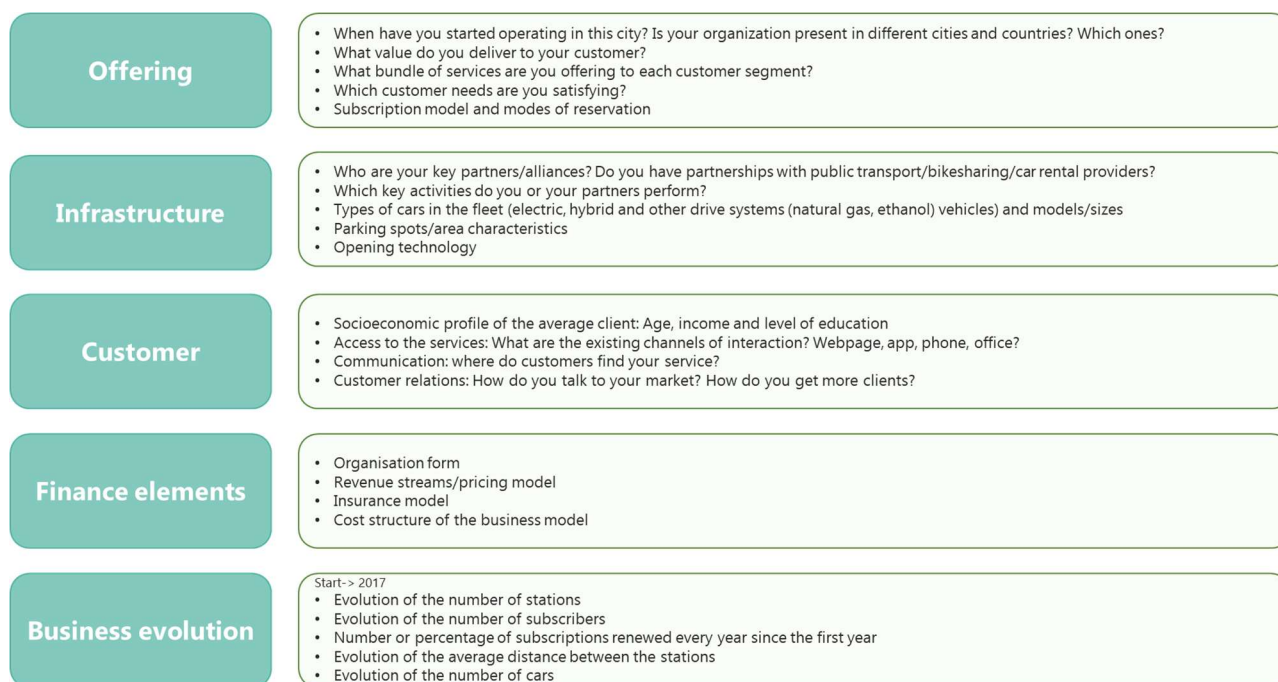
**Assessment of Critical Success Factors (CSFs) & Key Performance Indicators (KPIs):** Finally, the specific activities and interventions that could influence the development of the car sharing operator were assessed applying a rating criterion. To conclude, case studies have been compared.

	Phase 1: Analysis of internal factors	Phase 2 : Analysis of external factors	Phase 3 : Case study assessment
<b>Objectives</b>	<ul style="list-style-type: none"> <li>Analyse internal factors influencing the development of the carsharing service</li> <li>Analyse the business performance at different stages</li> </ul>	Analyse city/local related factors driving or challenging the development of carsharing services	Assess the specific interventions and activities that could influence the development of car sharing operators in each individual case
<b>Method</b>	<ul style="list-style-type: none"> <li>✓ Desk research</li> <li>✓ Business Model Canvas</li> <li>✓ Interview with car-sharing operator</li> </ul>	<ul style="list-style-type: none"> <li>✓ Desk research</li> <li>✓ PESTEL framework tool</li> <li>✓ Interview with transportation planner</li> </ul>	Rating criteria (-1, 0, 1 )
<b>Source</b>	Carsharing literature, carsharing operator, online blogs, related EU project reports	Carsharing literature, local transportation planners, carsharing association, SUMP action plans, related EU project reports	Use cases assessment literature review
<b>Results</b>	<ul style="list-style-type: none"> <li>Mapping of customer, infrastructure , offering &amp; finance elements of the BM</li> <li>Evolution of business performance indicators</li> </ul>	Mapping of political, economic, social, technological and environmental driving activities/factors in the specific city	<ul style="list-style-type: none"> <li>Multi-variable graphical representation of the driving forces of the case study</li> <li>Concluding remarks</li> </ul>

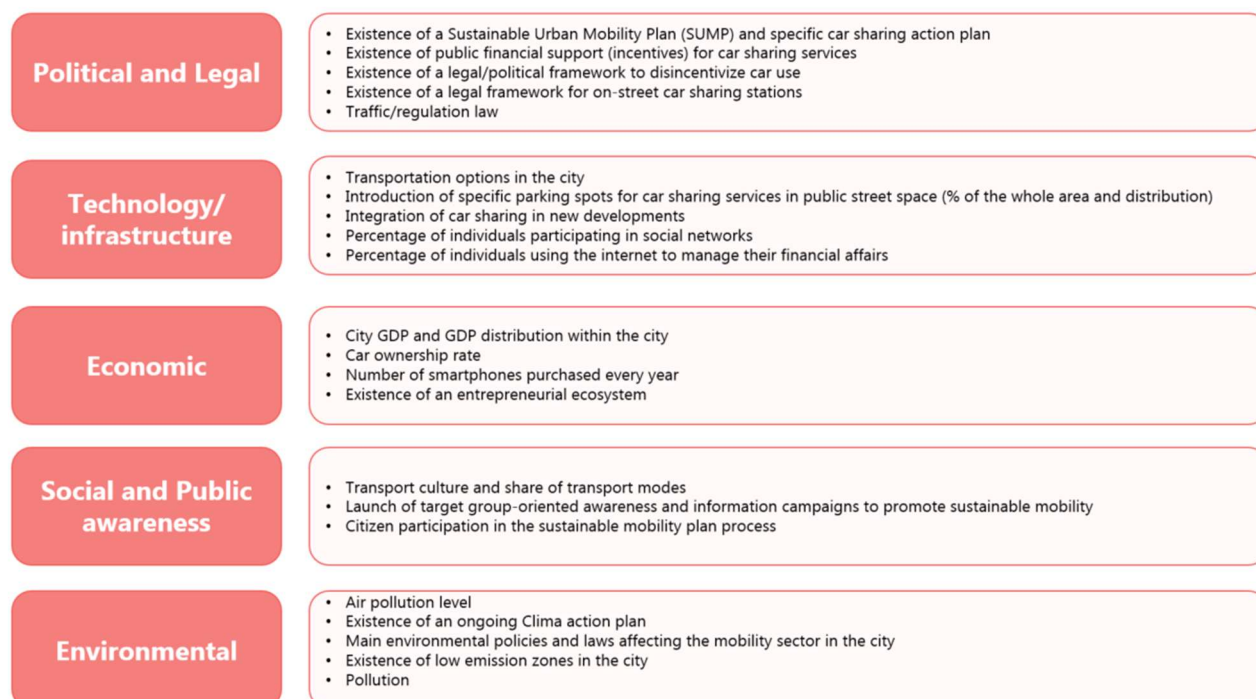
**Figure 28: Methodology applied to the three case studies**



For the analysis of both internal and external factors, an analytical framework was developed. Figure 29 and Figure 30 below present the different research questions used to assess these dimensions:



**Figure 29: Initial analytical framework of internal factors**



**Figure 30: Initial analytical framework of external factors**

External factors can work as disincentives or incentives for car sharing operations in a specific city. As well, there are internal factors that could work as positive or negative drivers facilitating or hindering the activities of a car sharing operator.

The STARS team used the following criteria to assess the specific interventions and activities that could influence the development of car sharing operators in each individual case (see Table 1). Indeed, this allows the comparison between use cases. In particular, external and internal disincentives and drivers of failure were assigned a rate of -1 and external and internal incentives and drivers of success held a rate of +1.

**Table 1: Rating of external and internal factors**

	-1	0	1
<b>Political &amp; legal</b>	Non-political or legal framework	Car sharing is mentioned in a political or legal instrument	Specific political and/or legal instruments on car sharing
<b>Economic</b>	Low economic dynamism	Stable economy and economic dynamism	Dynamic economy, high entrepreneurship culture
<b>Social</b>	Strong car ownership culture, resistance to innovation and to new mobility services	Indifference or lack of awareness about car sharing	Car sharing culture and enthusiasm toward new technologies and mobility services
<b>Technological</b>	No multi modal transport offer, low density of public transportation	Multi modal transport offer	Multi modal transport offer, 2.0 mobility services
<b>Environmental</b>	Lack of environmental and climate change targets	Environmental and climate change targets	Environmental & climate change targets and actions plans to transform the mobility sector
<b>Value proposition, activities &amp; resources</b>	Offer does not suit clients' needs in the specific city	Offer that is attractive but not practical	Attractive and practical offer
<b>Cost structure &amp; revenue streams</b>	Unbalanced business plan	Balanced business plan	Balance between costs & revenues, & economic benefits
<b>Business performance indicators</b>	Lack of steady business development	Steady business development	Exponential and steady business development

### 3.1 Case study 1: Autolib in Paris



Figure 31: Autolib's station in Paris (LGI, 2018)

#### Case summary

In February 2011, Autolib, the car sharing service offered by the Paris Municipality and Île de France, was launched. It is operated as an association run by the Bolloré Group, an international group operating in various fields, including transport and logistics.

Autolib is considered a pioneer for being the first extensive, public electric car sharing ever offered in a municipal level as an extension of the public transport services (Bolloré, 2018).

#### ★ The city of Paris

Paris is the capital of France and the most populated city in the country, with a population of 2,220,445 million inhabitants and a territory of 10,539 hectares (C. Dubois, 2017). Paris is the economic engine of the country; its GDP represents 30.9% of the French GDP (Paris Region, 2016). In addition to its economic relevance for France and the entire European Union, Paris is also the most visited city in the world.

In 2017, there were 32,074,202 passenger cars with less than fifteen years in France ('Parc des véhicules au 1er janvier 2017', 2017). In 2016, the city of Paris had 142,900 on-road public parking spots and 2,800 hectares dedicated to motorised traffic.

Table 2 shows Paris' transport modal split, highlighting the predominance of travels by foot and by public transportation.

It is not surprising that the Parisians often opt for the public transport option, since Paris has an extremely dense public transport network. There are over 245 metro stations within the city limits with a radius of 5 KM between stations. However, the use of public transport options in the inner city is also driven by the limited space for parking in streets and the major issue of road congestion. As may be seen from table below, when going out of the inner city, car travel is one of the preferred modes.

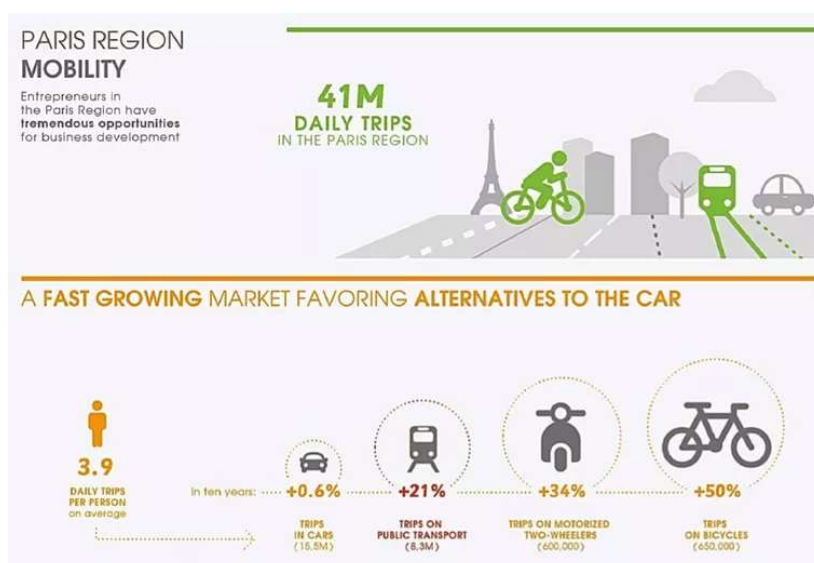
	Île de France	Paris
<b>Foot</b>	<b>38,7%</b>	<b>60,5%</b>
<b>Bike</b>	<b>1,6%</b>	<b>3%</b>
<b>Motorbikes</b>	<b>1,4%</b>	<b>1,8%</b>
<b>Public transport</b>	<b>20,1%</b>	<b>27,3%</b>
<b>Cars</b>	<b>37,8%</b>	<b>6,7%</b>

**Table 2: Paris' transport modal split (Christophe Najdovski, 2017)**

### ★ Development of shared mobility solutions

Sustainable mobility is on the top of the agenda for Parisian policymakers. As a result, Paris was ranked first in the SMCI Shared Mobility Index 2016 (SMCI, 2016). Other initiatives that show their commitment are: The Grand Paris Express, a €32 billion project that envisions the creation of 127 miles of fully-automated metros lines, four new lines and the extension of two exiting lines; The replacement of the entire public bus fleet, a total of 4,500 buses, with electric or natural gas vehicles; The promotion of shared mobility with the deployment of Autolib car sharing service for electric vehicles; and the extension of cycle paths to reach total of 870 miles by 2020 (Emilie Jessula, 2016).

Paris has a dynamic mobility ecosystem that brings together large groups (e.g. Renault, Bolloré and PSA), startups (e.g. Drivy, Cityscoot and Blablacar), competitive clusters (e.g. Mov'eo and Advancity), and incubators and accelerators (e.g. La Fabrique des Mobilités and Via-Id). As shown in Figure 32, the Paris region mobility sector is a growing market that offers tremendous opportunities for entrepreneurs and innovators in this sector.



**Figure 32: Paris Region Mobility Sector Opportunities (Emilie Jessula, 2016)**

According to a study carried out by 6t in partnership with ADEME<sup>28</sup> in 2016 in France, every car sharing vehicle replaces 5 private cars and liberates 4 parking places. That is why the City of Paris supports car sharing solutions. Two evidences of this support were the creation of a Service Label for Shared Mobility (SVP), a label that provide operators over 200 parking spaces facilitating the use of car sharing, and the adoption of Autolib in 2011 (Paris Region, 2016).

Autolib is a self-service of public all-electric vehicles. This station-based service allows users to book a charging terminal and parking close to their destination, with no need to bring back the car to the departure station. Every week over 100,000 trips are made in Paris by Autolib (Autolib Métropole, 2016). It is a pollution-free motorised transport option that has been integrated in the Paris transport network.

### 3.1.1 Analysis of internal factors

#### The performance analysis

Five performance indicators were selected to provide an overview of Autolib's business development overtime: number of subscription, number of stations, charging terminals, average number of cars available for the service and the income generated linked subscription and additional trips.

<sup>28</sup> French Environment and Energy Management Agency  
GA n°769513

	2014	2015	2016
<b>Number of subscriptions</b>	68582	99941	133307
<b>Number of stations</b>	870	1042	1086
<b>Charging terminals</b>	4652	5838	6112
<b>Average number of cars available for the service</b>	2649	3309	3923
<b>Income generated (linked to subscriptions and additional trips cost)</b>	42425015	56020184	60587941

**Table 3: Autolib's performance indicators for 2014, 2015 and 2016** (Autolib Métropole, 2014) (Autolib Métropole, 2015) (Autolib Métropole, 2016)


The indicators listed in Table 3 show a clear evolution from 2014 to 2016, in terms of number of subscription and average cars available for the service. On the other hand, the number of charging terminals per stations remained between 5 and 6.


However, due to the high fixed costs from the vehicle fleet acquisition and EV network infrastructure, this business model is not currently profitable. In fact, there is a disproportion between the evolution of subscriptions and the income generated from subscriptions and additional trip costs. While between 2014 and 2016, the number of subscription has increased 94,37%, the income generated incremented only 42,81% in the same period. This may be explained by the fact that although the number of subscriptions is increasing the frequency of use of the service by subscribers decreases number of trips per member is declining, while the service cost remain high (Mounia Van de Castele, 2017). A detailed discussion on this is provided in section 3.1.3.

### **Business model**

Autolib targets both eco-conscious individuals and urban drivers who simply need a (compact) car to get around the city. The free-floating with pool station model allows members to take one-way trips and then park the car at a number of charging stations with ideal locations around the city. Autolib offers its members a service that is complementary to public transport, as many of the stations are located close to metro stations or bus stops. Users have the option of adding their Autolib account to their existing public transport card, making multi-modal transport easy. Charging stations are often strategically placed near metro stations or key commercial and residential areas. For members who buy an annual pass, they have the opportunity to earn points and access to a range of benefits and deals (<https://whaller.com/-autolib>).



 <b>Business Model Canvas</b>				
<b>Key partners</b> <ul style="list-style-type: none"> <li>- Local authorities</li> <li>- Public transport operators</li> <li>- Automotive companies (CECOMP)</li> <li>- Car design firm (Pininfarina)</li> <li>- Battery company (batScap)</li> <li>- Tyre company (Michelin)</li> <li>- Ap companies (Free2Move &amp; Citymapper)</li> <li>- Key shareholder: Bolloré Group</li> </ul>	<b>Key activities</b> <ul style="list-style-type: none"> <li>- Car rental</li> <li>- Fleet maintenance &amp; management</li> <li>- Customer service</li> </ul>	<b>Value Proposition</b> <ul style="list-style-type: none"> <li>- First fully-electric car sharing service in Paris</li> <li>- Low environmental impact</li> <li>- Integrated with public transport, &amp; drivers can use the same card</li> <li>- Club Autolib (extra) offers additional benefits &amp; deals</li> </ul>	<b>Customer relationships</b> <ul style="list-style-type: none"> <li>- Automated services through the website &amp; application interfaces</li> <li>- Customer service call center</li> </ul>	<b>Customer segments</b> <ul style="list-style-type: none"> <li>- Frequent users</li> <li>- Occasional users</li> <li>- Young drivers</li> <li>- Drivers with medium-high income who are well-educated</li> <li>- Eco-conscious individuals</li> <li>- Public transport commuters who sometimes need a car</li> <li>- Businesses</li> </ul>
<b>Key resources</b> <ul style="list-style-type: none"> <li>- Vehicle fleet</li> <li>- Charging stations</li> <li>- Integrated information system, website and application</li> <li>- Management &amp; service team</li> </ul>			<b>Channels</b> <ul style="list-style-type: none"> <li>- Website</li> <li>- Smartphone application</li> <li>- Customer service call-center</li> <li>- Other transport apps</li> </ul>	
<b>Cost structure</b> <ul style="list-style-type: none"> <li>- Installation of charging stations</li> <li>- Purchase, maintenance, cleaning &amp; recharging of fleet</li> <li>- Development &amp; maintenance of website &amp; app</li> <li>- Customer services &amp; insurance contracts</li> </ul>			<b>Revenue streams</b> <ul style="list-style-type: none"> <li>- Optional monthly subscription (€10) or reservation fee (€1)</li> <li>- Rental fees (per minute after 20 minutes of use)</li> <li>- Refundable deposit</li> </ul>	


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**Table 4: Autolib's Business Model Canvas**

Drivers pay based on the time they use the vehicle (per minute of use after a set fee for the first 20 minutes). They have the option of paying a monthly fee throughout the year, or paying a reservation fee (€1) each time they use the service<sup>29</sup>.

It is widely known that although 92% of users are satisfied by the service provided by Autolib (Autolib, 2017), economically it is not a successful public car sharing service. In 2015, the consulting firm 6t estimated that Autolib would need additional 82,000 customers to become rentable (Mounia Van de Castele, 2017). In November 2016, Autolib's Syndical Office predicted a deficit of 179 million Euros, from which two thirds will be financed by tax payers (Mounia Van de Castele, 2017). The reason why tax payer ended up paying the bill is to respect the original contract with Bolloré Group, which states that the private group is responsible for covering the losses of a maximum of 60 million Euros (Mounia Van de Castele, 2017).

<sup>29</sup> [https://www.autolib.eu/subscribe/offer\\_choice\\_session/](https://www.autolib.eu/subscribe/offer_choice_session/)  
 GA n°769513



### 3.1.2 Analysis of external factors

The figure below depicts an example of some of the existing interventions and activities in Paris influencing the deployment of car sharing programmes:

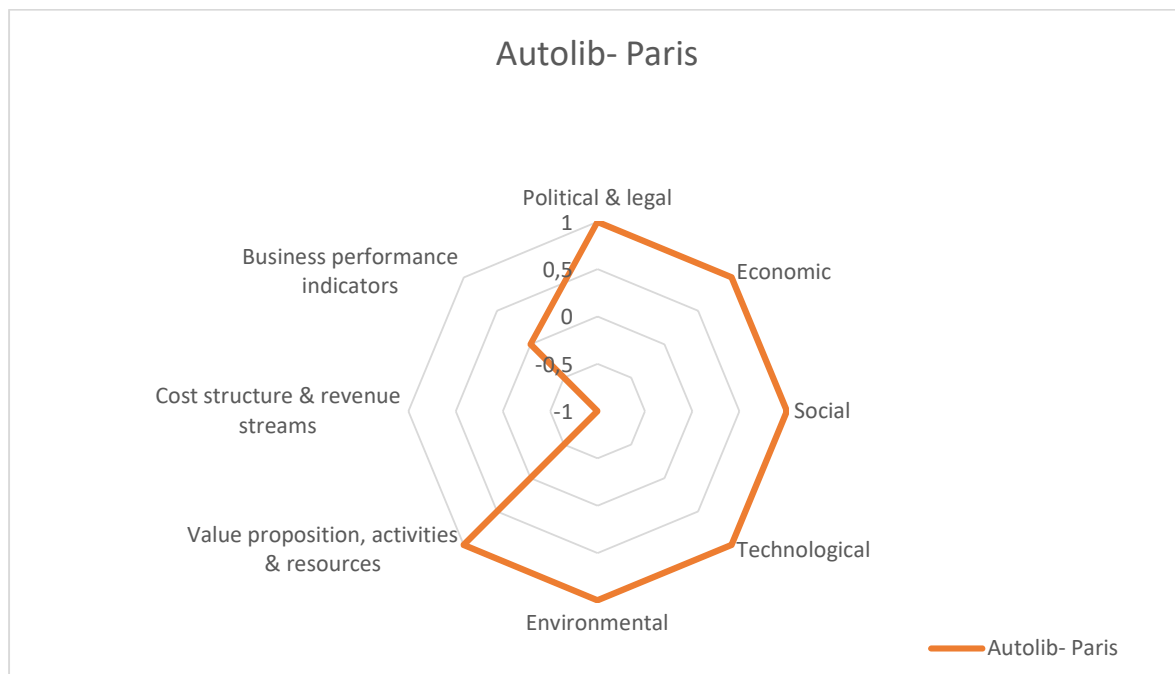
Driver dimension	Examples of Paris - specific existing interventions and activities
POLITICAL	<ul style="list-style-type: none"> <li>In 2011, the City of Paris integrated Autolib into its public transport network, raising awareness and changing the habits of the local population.</li> <li>The City of Paris has engaged in providing economic incentives for car owners that give up their cars to adopt other low-carbon transport options. The envisioned incentives are: 50% discount for the Autolib subscription fee, an economic help of 400€ for buying an electric bicycle, among others (Paula Torrente, 2016)</li> <li>The city of Paris has adopted the Bicycle Plan 2015-2020, which has the objective to bring the share of trips made by bike in Paris to 15% (Today, only 5% trips are made by bike) (Paula Torrente, 2016)</li> </ul>
LEGAL	<ul style="list-style-type: none"> <li>The concept of car sharing has been introduced in the French Transport Code in the article L.1231-14 (Ministère de la Transition écologique et solidaire, 2017).</li> <li>Article 54 of Law No. 2010-788 of 12 July 2010 expresses the national commitment to create the label "car-sharing" to allowing vehicles holding this label to benefit from reserved parking spaces and preferential rates (Ministère de la Transition écologique et solidaire, 2017).</li> <li>Many provisions encouraging the development of carsharing were taken in law n° 2015-992 of 17 August 2015 on the energy transition for green growth (TECV) (Ministère de la Transition écologique et solidaire, 2017).</li> </ul>
ECONOMIC	<ul style="list-style-type: none"> <li>In 2016, Paris GDP was of € 64,2b and the GDP per capita was of € 53,617. It represented 30,9% of the French GDP and 4,6% of the European Union's GDP (Paris Region, 2016).</li> <li>The Paris is home to over 12,000 startups (French Government, 2017). And the French President Emmanuel Macron has publicly announced his intention to turn France into a start-up nation.</li> </ul>
SOCIAL & PUBLIC AWARENESS	<ul style="list-style-type: none"> <li>According to a study carried out by 6t in partnership with ADEME, in 2016 in France: 1) car sharing is still a niche market for wealthy, older and well-educated people in relation big French cities population. 73% hold a BAC+3; 54% are men; 45 is the average age; and 3691 Euros is the average household income.</li> <li>The city of Paris has launched the challenge "Seven days without a car" to encourage car users to try other transport modes (Paula Torrente, 2016).</li> <li>The City of Paris has established a yearly 'Car Free Day' on the 25<sup>th</sup> of September (Paula Torrente, 2016).</li> </ul>
TECHNOLOGICAL/ INFRASTRUCTURE	<ul style="list-style-type: none"> <li>Paris has one of the densest public transport network in the world. There are over 245 metro stations within the city limits with a radius of 5KM between stations.</li> <li>The Grand Paris Express is a urban project that envisions the creation of four new metro lines (15,16,17 and 18) and the extension of lines 11 and 14. It contemplates the creation of 125 miles of automated metro lines and 57 new stations (French Government, 2017).</li> <li>Paris counts with booming mobility market and a rich and diverse ecosystem composed by big groups, startups and competitive clusters. Startup such as BlaBlaCar or Cityscoot are part of the mobility ecosystem.</li> </ul>
ENVIRONMENTAL	<ul style="list-style-type: none"> <li>In 2016, concentration levels of nitrogen dioxide and particulate matter in the Paris region were much higher than the accepted European limits. So, air pollution remain problematic (Airparif, 2017)</li> <li>Paris has an Environmental Plan that sets targets for turning the French capital into a healthier place for its inhabitants and reducing pollution levels by implementing improvements in the transport sector.</li> </ul>

Figure 33: External factors impacting Autolib in Paris

### 3.1.3 Case 1 conclusion

Autolib is an example of leadership and innovation. Together with the city of Paris, the Group Bolloré introduced a self-service full-electric car sharing service in Paris that contributes to reducing noise and air pollution, while it increases the public transport offer for Parisians. The model became a reference worldwide with many cities replicating and adapting it to their own needs (e.g. Torino, Boudreaux and London).

As seen in Figure 34, Autolib emerged in a context with plenty external positive factors, such as political and legal support to car sharing, economic dynamism and in a city with a vivid mobility sector that explores new services and forms of transport. Moreover, Autolib is part of an awareness campaign led by the City of Paris that promotes shared and sustainable mobility.



**Figure 34: Autolib's use case assessment**

However, Autolib's internal factors can challenge its continuity in the future. Although Autolib has a high satisfaction level, the services costs (from the vehicle fleet acquisition and EV network infrastructure) are much superior than the income generated. Moreover, its growth is steady but slower than needed to achieve financial balance. The question of the economic model of Autolib' is therefore all the more pressing given that free floating car sharing services with pool stations, have already been deployed by the Bolloré group in Europe, in Lyon, Bordeaux, Turin and London, as well as abroad, in Indianapolis (United States) and Singapore. As a result, a more detailed discussion on their economic model will be provided (compared to other case studies).

As a way to improve the profitability of this business model, a diversification of sources of revenue is under discussion. First, the Bolloré group could subsidise their shared mobility service of the Paris

area. However, according to, Vincent Bolloré, CEO of the investment group Bolloré, this is difficult to believe<sup>30</sup>. Second, marketing and advertising on cars could help covering deficits. This approach has been tested on 10% of the fleet since October 2016, but its generalisation and sustainability will prove complicated to legitimate, due to a local law which prohibits the parking on public roads of vehicles used as a medium for advertising<sup>31</sup>. Third, the local authority could co finance this service through local taxes. Finally, the user could pay more for the service, which according to 6t, this is perhaps the most equitable solution when it is known that Autolib' users have incomes 27% higher than the average of Parisian household and that one kilometre using Autolib' costs them an average of €1.13, against €2.40 for a kilometre by taxi<sup>32</sup>.

To conclude, it should be noted that organisations operating under this business model could face even more feasibility challenges in less densely populated areas, as evidenced in Lyon (the Bluely service in Lyon recorded less than one rental per car per day in 2016 against 4,1 in Paris in December 2016<sup>33</sup>). In fact, the density of Paris is one of the driver factor since it implies a greater number of potential users in the vicinity of each station, which makes it possible to provide a large number of stations, thus a large number of potential journeys.

To conclude, from this analysis it becomes clear that Autolib is partially successful for its service, clients' satisfaction and technology, but the difficulty in achieving financial balance in Paris questions the replicability of this business model.

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<sup>30</sup> <https://6-t.co/autolib-nest-toujours-pas-rentable-et-ne-le-sera-peut-etre-jamais/>

<sup>31</sup> *Article R581-48 of the Environmental Code*, on the <https://www.legifrance.gouv.fr/site>

<sup>32</sup> <http://www.ademe.fr/sites/default/files/assets/documents/autopartage-particuliers-ena4.pdf>

<sup>33</sup> <http://www.leprogres.fr/lyon/2016/10/19/bluely-service-d-autopartage-continue-sur-sa-lancee>

## 3.2 Case study 2: Cambio in Bremen



**Figure 35: Cambio's station in Bremen ('City of Nürnberg follows Bremen's Example – mobil.punkte to Reduce Parking Pressure in City', 2016)**

### Case summary

This case study tells the story of Cambio, a leading car sharing operator, in the city of Bremen, Germany. Cambio is a profit-based organisation that offers roundtrip station-based car sharing services with a defined pick-up and return station.

Cambio started operating in the city of Bremen in 1990. Today, it is present in at least three cities in Belgium and in twenty-one cities in Germany, namely Aachen, Berlin, Bonn and Hamburg among others. There is as well a roaming partnership with the Stadtmobil car sharing group – so with a cambio card, you can use car sharing cars all over Germany.

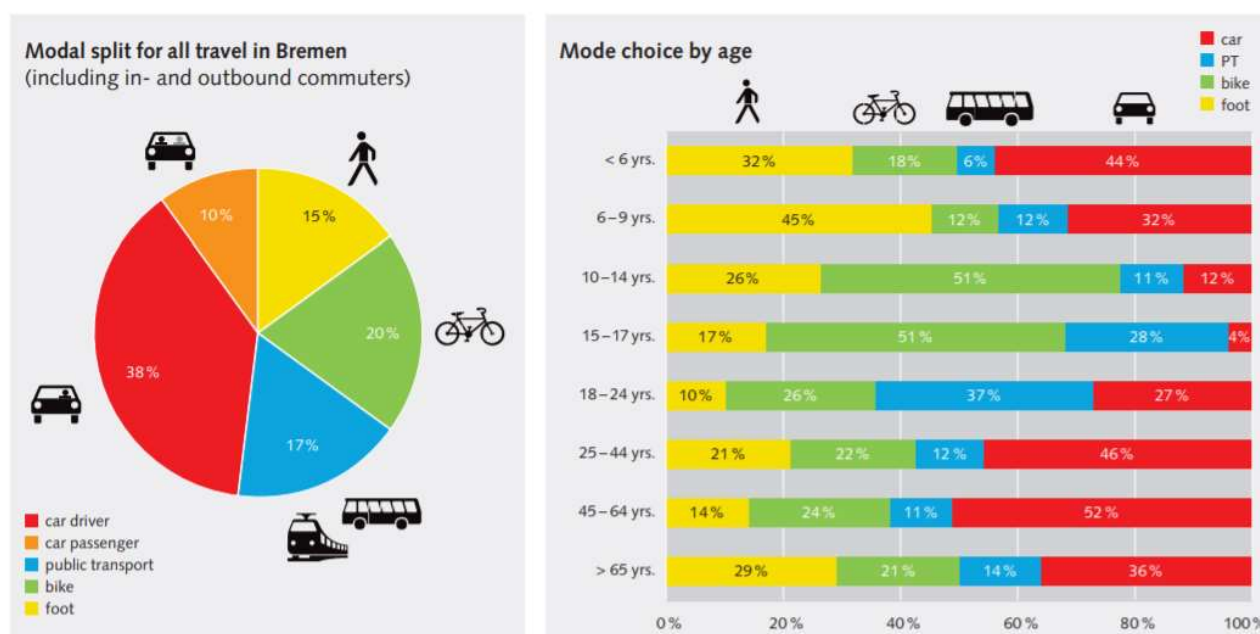
#### ★ The city of Bremen

Bremen is a city of 548 547 inhabitants, located in Northwest Germany. It is known for the maritime trade through the Weser River and for the Hanseatic buildings and world heritage architecture on the Market Square (Hanseatic City of Bremen., 2018).



Two surveys carried out in 2008, provided a detailed picture of Bremeners' transport behaviour. Compared to any North American car-dependent city, Bremen could be considered highly car free, with 420,000 bicycle trips per day and 52% of the population relying on public transport, bikes or foot (Senator for Environment, Construction and Transport Bremen, 2014). Still, city planners are convinced that there is still room for improvements as congestion remains a problem in Bremen's historic and narrow streets, where it is normal to see cars half-hoisted on sidewalks.

Figure 36 shows Bremen's modal split in 2008 and the differences in transport mode choices among different age groups. For example, over 44% of children younger than six years old and adults from twenty-five to sixty-four years old drive by private cars. This choice changes mainly during teenagerhood, when 51% of the trips are made by bike. The overall picture for all citizens is of 48% of journeys by car and 52% by public transport, bicycle and foot.



**Figure 36: Bremen's Transport Modal Split in 2008 (Senator for Environment, Construction and Transport Bremen, 2014)**

Car ownership has gone from 258.846 in 2008 to 290.188 in 2018 (Interview with Bremen transport planner). The number of car-free households in 2013 was 29% in comparison to 36% in 2008 (SrV, 2017). This growth indicates that car ownership is still an option for the citizens of Bremen – rather on the periphery than in the central neighbourhoods, where car ownership is low. Consequently, the City of Bremen integrates ride stations into the existing 4,310 parking spaces to promote the use of bikes and multi modal transport (Senator for Environment, Construction and Transport Bremen, 2014).

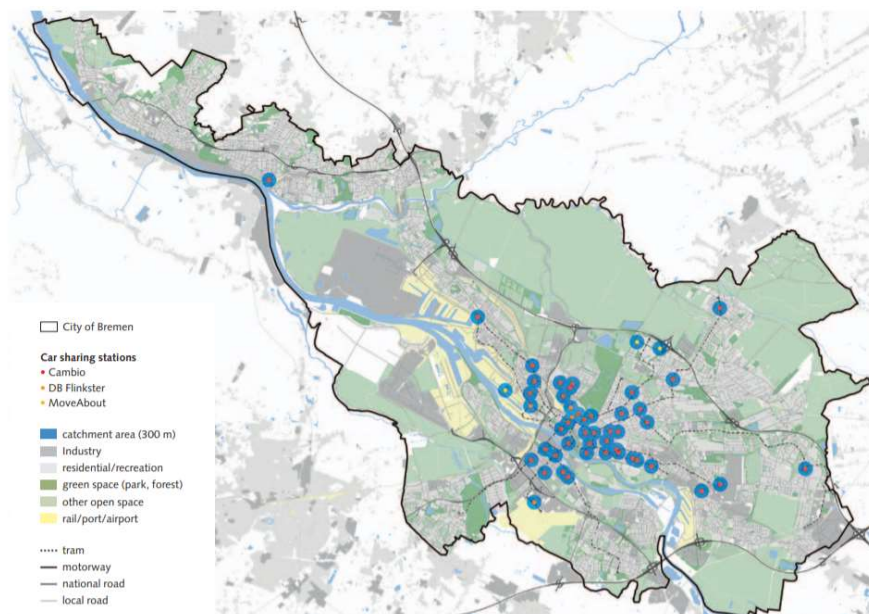
## ★ Development of shared mobility solutions

In 1990, car sharing began in Bremen as small private club that later became a mid-size business. The City of Bremen started supporting car sharing from its inception by building collaborations with Cambio and other car sharing providers. The first step was already in 1998 to integrate a car sharing option into the 'Bremer Karte', the local transit pass. Since then, car sharing users can upgrade to a Bremen Karte plus AutoCard that includes car sharing payment options (Kolson Hurley, 2014).

The municipality understood that car sharing could be an alternative to car ownership and urged citizens to give up cars and use car sharing instead. Consequently, in 2003, Bremen was the first city in Germany to dedicate public street spaces to car sharing with the introduction of the "mobil.punkt", mobility stations that combine car sharing stations with public transport stations, taxi stands, which are easy for cycling and have pedestrian access ('City of Nürnberg follows Bremen's Example – mobil.punkte to Reduce Parking Pressure in City', 2016).

Later in 2009, Bremen was the first city worldwide to create a car sharing action plan and to establish an ambitious target of 20000 car sharing users by 2020, quadrupling the number of 5000 users in 2009 when the strategy was adopted (Interview with city planner, 2018). This city plan envisions the creation of dedicated car sharing stations on public street space; car sharing parking lots on other publicly accessible spots (e.g. shopping centers, administration parking and hospitals); integration into new developments, with fleet management, dedicated awareness campaigns among others.

Figure 37 shows the presence of car sharing in the metropolitan area of Bremen. This map indicates that in 2012 car sharing stations were more concentrated in the city center in multiple catchment areas of 300 meters.



**Figure 37: Car sharing presence in Bremen's territory in December 2012 (Senator for Environment, Construction and Transport Bremen, 2014)**

A survey carried out in 2010 has shown that 44% of car sharing users in Bremen had a car before joining. After joining car sharing, two-thirds of those users decided to get rid of their cars ((Kolson Hurley, 2014). The city of Bremen is convinced that the station-based model is one of the reasons for their success and is determined to pursue in that direction. They believe that this model proved to users that car sharing is reliable as you can book a car in advance as well as spontaneously.

Today, Cambio's car sharing services are part of the local public transport system of the City of Bremen. Bremen has about 100 car sharing stations with an offer of more than 300 vehicles to over 14000 registered users ('Die Car-Sharing-Station in Bremen', 2017).

Now that car sharing is better known and the disadvantages of owning a car are more evident, the City of Bremen expects a significant growth of the number of car sharing users in the years to come. Cambio shares the same optimism, as it expects a business growth and car fleet increase of more than 5% (Survey for car sharing operators, STARS, 2018). The number of users in Bremen grew in 2017 by 15% (Interview with city planner, 2018).

In addition, Cambio intends to develop in smaller cities near Bremen and in suburban areas. Moreover, Cambio expects that the diffusion of green vehicles (electric, hydrogen cars), autonomous vehicles, the integration of car sharing into transport services and the diffusion of mobility smartphone applications, are going to have a positive impact on its business.

The City of Bremen has been carrying out a number of campaigns raising awareness and promoting car sharing as alternative to car ownership. The City of Bremen created the car sharing hero UDO – a German name but as well the acronym for *use it – don't own it*. The UDO cinema commercial<sup>34</sup> – presented in Bremen cinemas in 2016- was translated into English<sup>35</sup>, Norwegian<sup>36</sup> and Dutch<sup>37</sup> ('Die Car-Sharing-Station in Bremen', 2017).

### 3.2.1 Analysis of internal factors

#### The performance analysis

Indicators such as number of car users, number of stations and number of cars were used for Cambio's performance analysis. The choice of indicators was based on the availability of data. And the goal of the performance analysis is to illustrate how Cambio's activities have evolved over time in the city of Bremen.

As shown in Table 5 the number of Cambio customers has evolved from 2005 and 2017 significantly, indicating an important business development. Interestingly, following the previously discussed trends in Chapter 2, business development occurred more intensively between 2010 and 2017 than in the early 2000's.

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<sup>34</sup> German version on YouTube: <https://www.youtube.com/watch?v=ocwVYNvs340>

<sup>35</sup> English version on YouTube: [https://www.youtube.com/watch?v=5seE\\_26FYFA](https://www.youtube.com/watch?v=5seE_26FYFA)

<sup>36</sup> Norwegian version on YouTube <https://www.youtube.com/watch?v=yaBAzyZIC9A>

<sup>37</sup> Dutch version on YouTube: <https://www.youtube.com/watch?v=rM7LEUkXWnU&feature=youtu.be>



Furthermore, the number of stations and cars indicate how Cambio's internal resources have evolved in parallel to the business development.


	2005	2010	2017
<b>Number of users</b>	3,520	6,118	14,000
<b>Number of stations</b>	37	42	95
<b>Number of cars</b>	103	154	≈ 300

**Table 5: Cambio's performance indicators for 2005, 2010 and 2017(Cambio, 2005) (Cambio, 2010)**

From Cambio's performance analysis, it becomes clear that the company has succeeded in creating a value proposition that increasingly attracts new customers. On the other hand, the company's resources, namely cars and stations, have evolved to preserve the service quality and client satisfaction.

### **Business model**

Cambio offers price plans that target students and young drivers, occasional drivers, and drivers going long distances or on long trips. Cambio partners with the automotive industry, local governments, public service providers, and public transport operators. One major benefit that members receive is that they can drive the cars in Germany and Belgium. Moreover, thanks to the cooperation with the local government, Cambio members have access to sharing parking spaces on public ground in mobil.punkte multifunctional stations.

 <b>Business Model Canvas</b>				
<b>Key partners</b> <ul style="list-style-type: none"> <li>- Automotive industry</li> <li>- Housing projects</li> <li>- Local government</li> <li>- City council</li> <li>- Public service providers</li> <li>- Public transport operators (for marketing / customer service, digital integration)</li> <li>- Car manufacturers (depending upon the branch)</li> </ul>	<b>Key activities</b> <ul style="list-style-type: none"> <li>- Fleet maintenance</li> <li>- Customer service</li> </ul>	<b>Value Proposition</b> <ul style="list-style-type: none"> <li>- Users of public transport have special tariffs, &amp; can use the same key card</li> <li>- Complementary to public transport</li> <li>- No fuel costs</li> <li>- Cars can be driven in multiple European countries</li> <li>- Free city parking</li> <li>- Offers electric cars</li> </ul>	<b>Customer relationships</b> <ul style="list-style-type: none"> <li>- Customer service call centre</li> </ul>	<b>Customer segments</b> <ul style="list-style-type: none"> <li>- Occasional users</li> <li>- Students &amp; young drivers</li> <li>- Drivers going long distances or on long trips</li> </ul>
	<b>Key resources</b> <ul style="list-style-type: none"> <li>- Vehicle fleet</li> <li>- Platform</li> <li>- Partnerships with local government</li> <li>- Chip card</li> </ul>		<b>Channels</b> <ul style="list-style-type: none"> <li>- Website</li> <li>- Mobile app</li> <li>- Customer service call centre</li> </ul>	
<b>Cost structure</b> <ul style="list-style-type: none"> <li>- Vehicle fleet acquisition</li> <li>- Fleet maintenance &amp; cleaning</li> <li>- Platform development &amp; management</li> <li>- Insurance costs</li> <li>- Personnel costs</li> </ul>			<b>Revenue streams</b> <ul style="list-style-type: none"> <li>- Subscription fees (depending on branch, €0-€35)</li> <li>- Usage fees (per hour &amp; every 15 minutes, and per km)</li> <li>- Deposit, depending upon the branch (€0-€500)</li> </ul>	



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Adapted by: L&G Consulting

**Table 6: Cambio's Business Model Canvas**

Subscription fees depend upon the branch, ranging from zero to €35. The deposit is also conditional and could be as much as €500. Usage fees are charged based on the kilometres driven as well as time travelled (per hour and every 15 minutes).

The company's key resource is its car fleet, composed by economy city cars, family cars, sedans, vans, transporter, bus for 9 persons and electric cars. Cambio's car fleet is composed of 60,6% of diesel-based vehicles and only 1,3% of electric or 3,2% hybrid vehicles (Survey for car sharing operators, STARS, 2018). In addition to the car fleet, the online platform, the partnership with the local government and the chip card to open the cars were identified as complementary resources.

### 3.2.2 Analysis of external factors

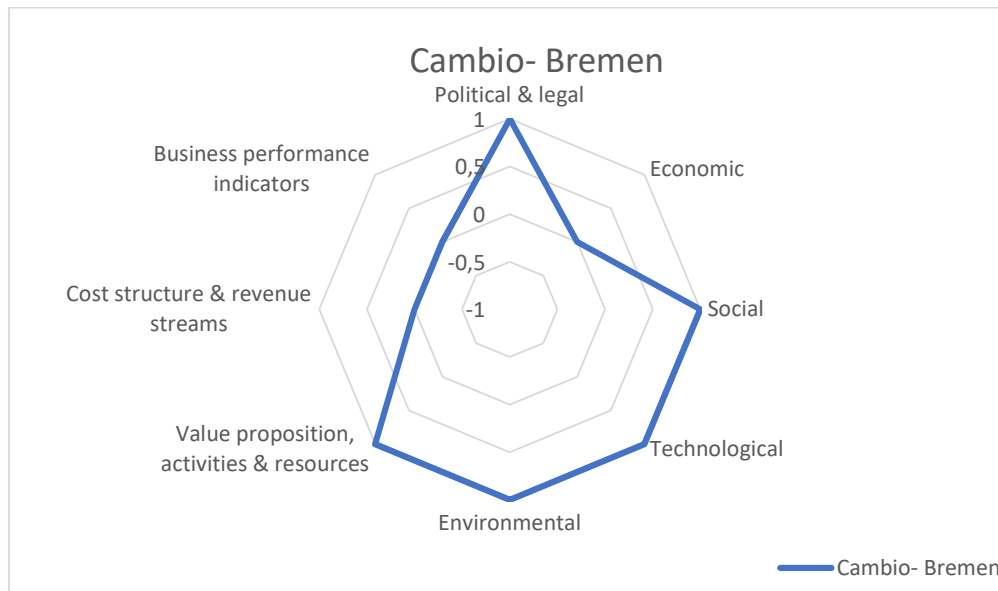
Figure below depicts an example of some of the existing interventions in Bremen influencing the deployment of car sharing programmes:

Driver dimension	Examples of Bremen - specific existing interventions and activities
<b>POLITICAL</b>	<ul style="list-style-type: none"> <li>• Since 2009 Bremen has a city plan for carsharing (Interview).</li> <li>• In 2014, Bremen has adopted a Sustainable Urban Mobility Plan (SUMP) for 2025 built on the same principle of a car free multimodal transport system setting targets to improve the sustainability of the transport system as whole (Senator for Environment, Construction and Transport Bremen, 2014).</li> <li>• Bremen has established a carsharing target of 20000 users by 2020, as compared to 11000 users in 2015 (Interview).</li> <li>• The SUMP envisions the creation of dedicated car sharing stations on public street space and car sharing parking lots on other publicly accessible spots (e.g. shopping centres, administration parking and hospitals) (Senator for Environment, Construction and Transport Bremen, 2014).</li> <li>• To use public street spaces car sharing must fulfil the standards of the German Blue Angel environmental label and provide proof that they are relieving the car burden in public space (Kolson Hurley, 2014).</li> </ul>
<b>LEGAL</b>	<ul style="list-style-type: none"> <li>• Currently there is not yet a legal framework in Bremen regulating on-street carsharing stations.</li> <li>• Bremen's urban planners are aware that the amendment of the parking regulations is an important step to integrate car sharing into new construction projects from the beginning (Interview).</li> </ul>
<b>ECONOMIC</b>	<ul style="list-style-type: none"> <li>• Bremen is a city with more than 500 thousand inhabitants, with a growing economy and increasingly dynamic business environment.</li> <li>• Fitch Ratings has assigned the State of Bremen a long-term local currency rating of 'AAA' (REUTERS).</li> <li>• In 2015, Bremen's GDP was of €47,5b and the GDP per inhabitant was of €45,800, 28% higher than average German GDP per capita (European Commission, 2018).</li> </ul>
<b>SOCIAL &amp; PUBLIC AWARENESS</b>	<ul style="list-style-type: none"> <li>• Carsharing is present in Germany since a long time and has become part of the German culture in a way. The same is applicable for Bremen.</li> <li>• The Municipality of Bremen facilitates citizen participation in the city planning.</li> <li>• Plenty of activities to promote carsharing awareness have been carried out in Bremen, including training at schools and communication campaigns.</li> <li>• Car ownership has increased from 712,833 in 2008 to 771,573 in 2017 (Statista, 2018).</li> </ul>
<b>TECHNOLOGICAL/ INFRASTRUCTURE</b>	<ul style="list-style-type: none"> <li>• Modal split for all travel in Bremen is of 36% of journeys by car, 25% walking, 23% cycling and 16% by public transport (Senator for Environment, Construction and Transport Bremen, 2014).</li> <li>• The city of Bremen has developed new real state developments that include carsharing stations.</li> <li>• In 2013, Bremen had a motorway network of 80 km and an inland waterway network of 61km (Eurostat, 2017).</li> <li>• In 2017, there were 105 carsharing stations in Bremen.</li> </ul>
<b>ENVIRONMENTAL</b>	<ul style="list-style-type: none"> <li>• On a national level, Germany has adopted the Climate Action Plan and committed to become extensively greenhouse gas-neutral by 2050 (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety).</li> <li>• The City of Bremen has a "Sustainable Urban Planning" working group that is committed to integrating climate and environmental protection targets into urban planning.</li> <li>• Bremen's average annual pollution level is of 36 in the Plume Air Quality Index, which represents a moderate level (Plume Labs, 2018).</li> </ul>

**Figure 38: External factors impacting Cambio in Bremen**

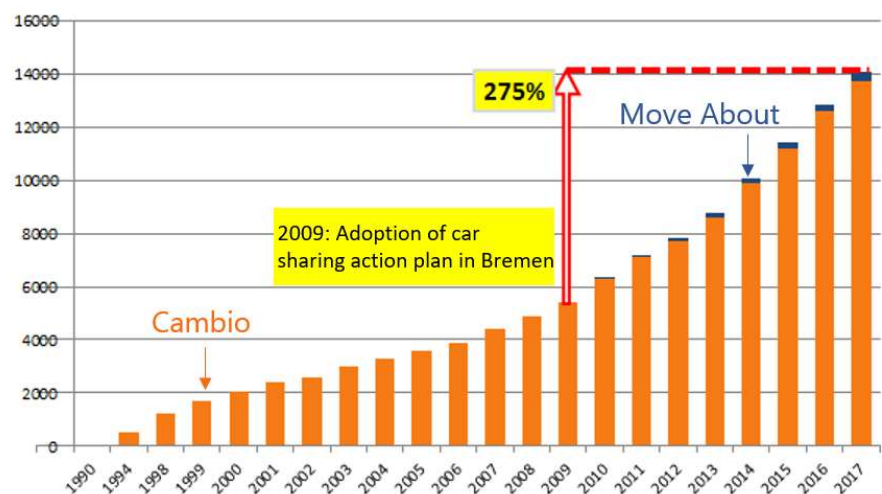
### 3.2.3 Case 2 conclusion

Cambio's use case could be classified as a successful story of a carsharing operator in a car sharing-friendly city. Figure 39 illustrates how the internal and external factors analysed are working as a driving force leading to the successful operations of Cambio in Bremen.



**Figure 39: Cambio's use case assessment**

The City of Bremen has been successfully integrating car sharing in its strategies for more than a decade, and is an example for other cities in Germany, in Europe and beyond. Therefore, external factors such as the political commitment (rated 1) and the environment protection measures (rated 1) proved to be the key drivers of car sharing uptake in Bremen and work as an incentive for Cambio operations in the German city. Car sharing is not a stand-alone measure but is embedded into overall urban development and transport strategies. Evidence of this is shown in figure below, where it is clear that with the adoption of the car sharing action plan in 2009, car sharing users increased by 275% compared to 2009 values.



**Figure 40: Car sharing deployment in Bremen before and after the adoption of the car sharing action plan (taken from the committee report, Michael Glotz-Richter)**

It should be noted that the package of concrete measures that the City of Bremen has undertaken to fully exploit the potential of car sharing creates a high level of synergy. This includes embedding car sharing in the overall transport and urban development strategy, on-street car sharing stations, integration into neighbourhood parking management, new urban developments and public transport, the establishment of quality standards/certification for car sharing operators wishing to receive support from the local authority and public relations and awareness raising, among others.

Other key drivers identified are technological and social, since Bremen has a good modal split and an ingrained cycling culture. In addition, many people in the city needs a car only from time to time (Kolson Hurley, 2014).

Regarding the internal factors, notably Cambio's overall business performance (rated 1), is one of the key reasons why Cambio operations are successful in Bremen. Cambio has continuously developed its business since 1990, rising awareness and progressively shifting the local culture towards car sharing. Cambio, with its wide variety of vehicles and the reliability of pre-reservation (but also the option of spontaneous bookings), has proved successful on reducing car ownership (compared to peer-to-peer and free floating). In fact, according to a survey conducted by Cambio in 2015, more than 11,000 users have replaced more than 3,700 cars from the streets of Bremen – end-to-end a row of cars of 20 kilometres.



### 3.3 Case study 3: Drivy in Barcelona

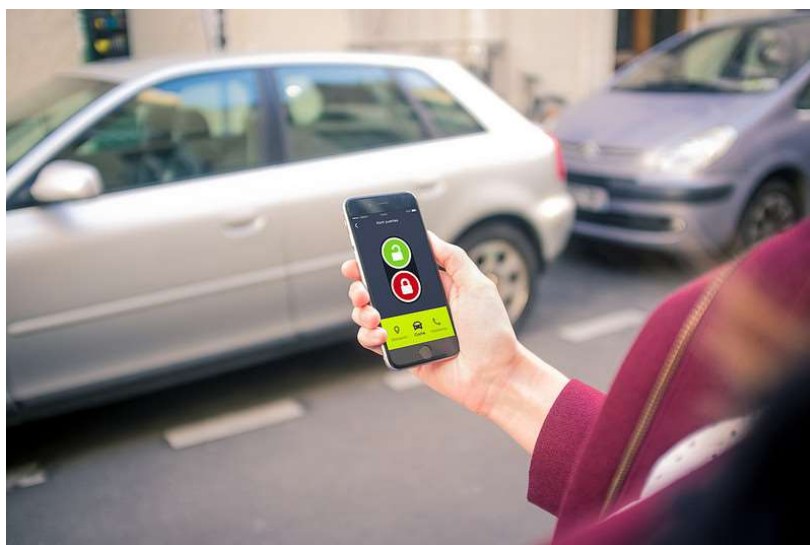


Figure 41: Drivy Open system (Drivy, 2018)

#### Case summary

Drivy is car-sharing startup formed in Marseille (France) in 2010 as a peer-to-peer that later developed becoming a hybrid platform for car sharing (including peer-to-peer and professional supply such as small rentacar companies and car dealers). Since 2010, it has grown into a business serving 1.5 million users with around 50,000 cars available for hire across France, Germany, Austria, Spain, Belgium, and most recently, UK. Drivy currently employs 100 people and is headquartered in Paris, with regional outposts in London, Berlin and Barcelona.

In 2015, Drivy arrived in Spain and started its operations in Barcelona and Madrid. This use case will tell the story of Drivy in Barcelona, from its inception until its latest development.

#### ★ The city of Barcelona

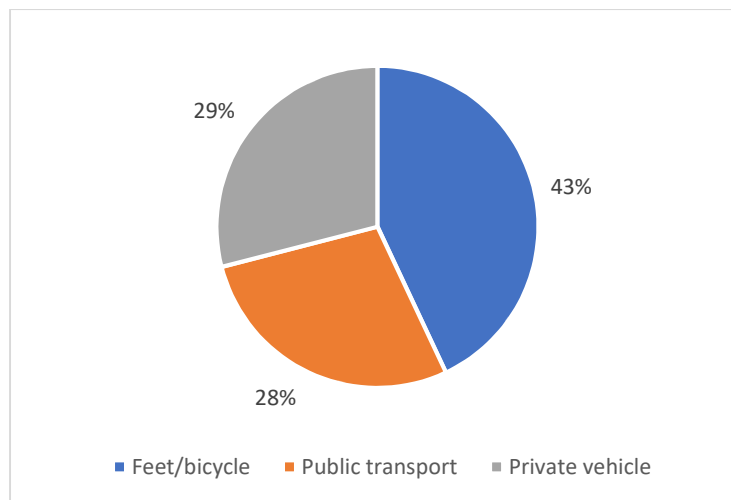
Barcelona is the capital and the largest city in the Autonomous Community of Catalonia in Spain. It has a population of 1,6 million within the city limits and around 4,6 million in the entire Province of Barcelona (Generalitat de Catalunya, 2016). Barcelona is the largest on western Mediterranean Sea. It is located by the cost, between the Llobregat and the Besos Rivers and bounded to the west by the Serra de Collserola mountain range.

Barcelona's public transport network is composed of tram and train services, metro, bus, cable car and funicular. The average distance Barcelona's citizens travel everyday with public transport is of 7.2 km and they spend an average of 50 minutes commuting (Moovit Insights, n.d.).

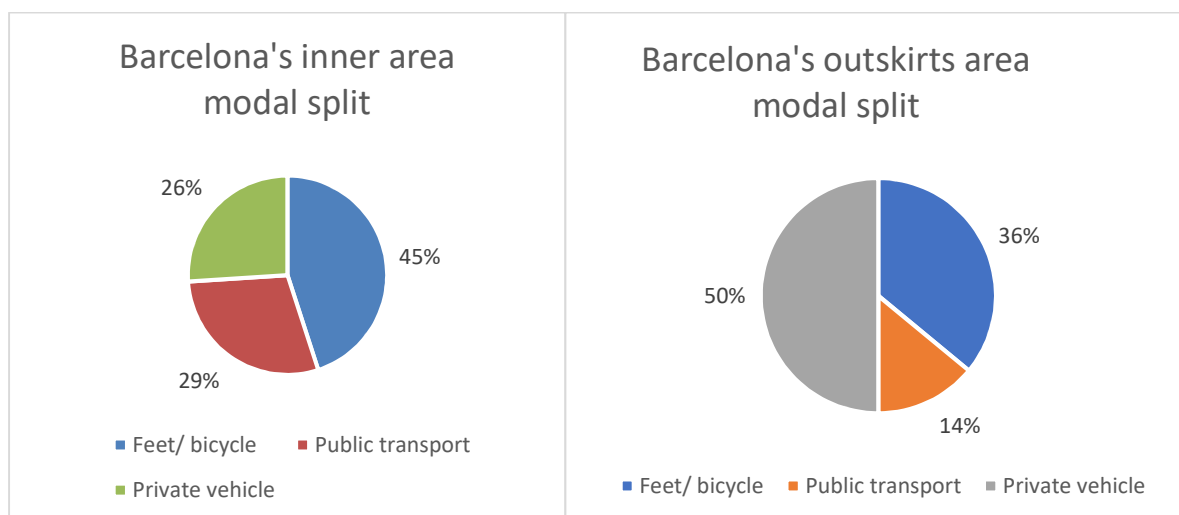
Barcelona has a reduced number of parking spaces, making it hard to own a car in the downtown. The total amount of on-street parking for passenger cars is of 141,747 on-street and 646,107 off-

street parking spots, with only around 600,00 parking spots dedicated to private passenger cars (Ajuntament de Barcelona, 2017).

Barcelona's transport modes include feet, bicycle, a public transport offer of buses and metro and private cars. As show in Figure 42 in 2016, the transport modal split in Barcelona's metropolitan area was predominantly by feet, bicycle, and public transport. Still, when looking into the differences between outskirts and inner Barcelona, it becomes clear that the existing transport infrastructure is localized in the downtown. And the population living in the outskirts has often no other choice that using private cars.



**Figure 42: Barcelona's metropolitan area transport modal split in 2016**



**Figure 43: Barcelona's inner area and outskirts transport modal split in 2016**



## ★ Development of shared mobility solutions

The City Council of Barcelona is aware that mobility models can directly determine the use of public spaces, therefore, it is committed to improve the quality of public urban spaces, reducing pollution levels and promoting sustainable mobility. With this in mind, the local authorities are supporting the uptake of mobility-management technologies and share mobility solutions (Ajuntament de Barcelona, 2017).

In 2014, the car sharing operator Avancar started its activities in Barcelona. Since then, car sharing service got increasingly accepted by the local market. Today, many other car sharing operators started exploring Barcelona's market, namely Ubeeqo, Bluemove, Zipcar and Drivy, among others. Drivy, the car sharing operator selected for this use case, was founded in France in 2010. Two years later raised 2 million Euros. Then, in 2015 it arrived in Spain, concretely in Barcelona and Madrid.

### 3.3.1 Analysis of internal factors

#### The performance analysis

Four indicators were selected for the performance analysis of Drivy Barcelona: the number of subscriptions, the number of cars, the average price and the average distance travelled. Since Drivy start its activities only in 2015, the timeframe of analysis is shorter compared to the other two use cases.

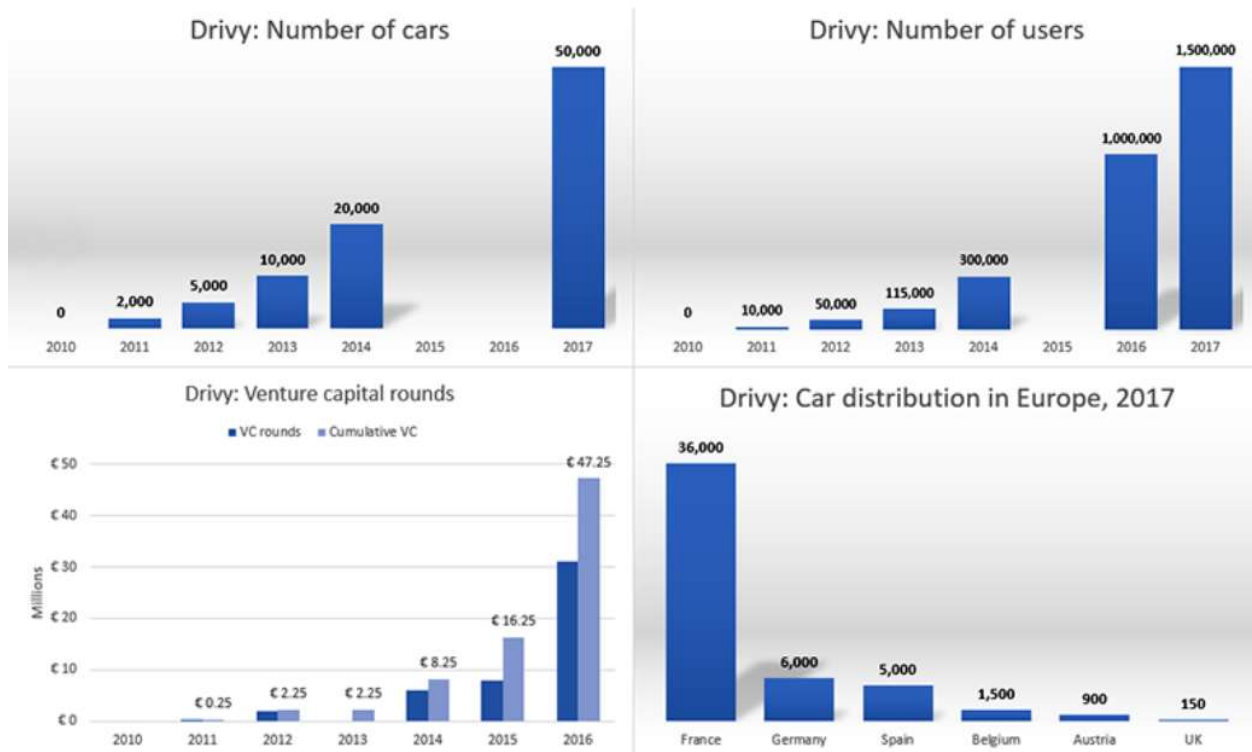
The number of subscriptions complies both car users and car owners, it refers to the number of subscribers to the Drivy market place. As shown in table below, the number of subscriptions to Drivy Barcelona has raised 1400% from 2015 to 2017. It went from 2000 to 30000 subscribers. On the other hand, the number of car owners using Drivy for generating additional income has increase 10 times between 2015 and 2017.

	December 2015	December 2016	December 2017
<b>Number of subscriptions</b>	2.000	10.000	30.000
<b>Number of cars</b>	100	300	1.000
<b>Average price</b>	31€/day	28€/day	28€/day
<b>Average distance travelled</b>	150Km/day	120Km/day	120Km/day

**Table 7: Drivy's performance indicators for 2015, 2016 and 2017 (Interview)**

Both the average price and the average distance of trips remained stable in those first three years of Drivy Barcelona. The average distance travelled by clients confirms that in Barcelona is used mainly for short trips to the countryside and to the seaside.

Overall, Drivy experience in Barcelona seems to be positive. From 2015 to 2017, the business experienced a rapid growth and development. Figure 44 shows how Drivy's fleet, users, capital and presence in Europe has evolved during the last years.



**Figure 44: Drivy development history in some figures: number of cars, number of users, venture capital rounds and car distribution in Europe(Charles McLellan, 2018)**

Drivy's win-win proposition explains its growth in several European cities. As a peer-to-peer car sharing, Drivy has two types of members: the car owners, who make their cars available on the platform; and the drivers using Drivy services. This model allows car owners to rent their cars when they are not using it to earn an extra money, while offering drivers the possibility to rent a car quickly, in close proximity and with the best price. Recently, it started allowing fleet owners and professionals to register their cars in the platform too, so users can now rent private and professional cars.

### **Business model**

The service offered by Drivy allows its users to rent other people's cars within walking distance of home whenever they need one: whether it is to attend a business meeting, go around the city, go away for a weekend, or move to a new house. Unlike its counterparts, Drivy does not try to capture drivers who need to take short trips inside a city – it focuses instead on having repeat customers, and drivers who are in need of a car for longer trips (<http://www.zdnet.com/article/drivy-airbnb-or-spotify-for-cars/>).

drivy Business Model Canvas				
<b>Key partners</b> <ul style="list-style-type: none"> <li>- Local governments</li> <li>- Allianz Insurance</li> <li>- Key shareholders: Nokia Growth Partner, Cathay Innovation, Index Ventures, Via ID, BPI France</li> </ul>	<b>Key activities</b> <ul style="list-style-type: none"> <li>- Service provision (unlocking cars remotely &amp; installing boxes)</li> <li>- Platform management</li> <li>- Insurance coverage</li> </ul>	<b>Value Proposition</b> <ul style="list-style-type: none"> <li>- Quick car rental</li> <li>- Cars in your neighborhood (cars nearby)</li> <li>- Self check-in and check-out via smartphone (Drivy Open)</li> <li>- No deposit required</li> <li>- No subscription fee</li> <li>- Car owners can earn money by renting out their vehicles</li> <li>- Car owners set the price</li> <li>- Drivers can leave reviews</li> </ul>	<b>Customer relationships</b> <ul style="list-style-type: none"> <li>- Dedicated customer service team</li> <li>- New members get training</li> <li>- Follow-up on all users' reports</li> <li>- Box installation</li> </ul>	<b>Customer segments</b> <ul style="list-style-type: none"> <li>- Drivers going outside cities, on longer trips</li> <li>- Young drivers</li> <li>- Repeat customers</li> </ul>
<b>Key resources</b> <ul style="list-style-type: none"> <li>- Network of car rentals</li> <li>- Platform</li> <li>- Insurance coverage</li> <li>- Drivy Open technology (box installed in cars)</li> </ul>			<b>Channels</b> <ul style="list-style-type: none"> <li>- Website</li> <li>- Mobile app</li> <li>- Phone</li> </ul>	
<b>Cost structure</b> <ul style="list-style-type: none"> <li>- IT systems</li> <li>- IT operations and maintenance</li> <li>- Marketing activities</li> <li>- Personnel costs</li> </ul>			<b>Revenue streams</b> <ul style="list-style-type: none"> <li>- For-profit: 15% commission on rental transactions (70% goes to car owner; 15% goes to insurance roadside-assistance costs)</li> <li>- Drivers pay by distance &amp; time travelled (daily, weekly, monthly, and per km)</li> </ul>	

Designed by: Business Model Foundry AG, The makers of Business Model Generation and Strategyzer  
Adapted by: L&G Consulting

**Table 8: Drivy's Business Model Canvas**

Moreover, the company brings together a community of people that wish to share the costs and responsibilities of having a car. By encouraging private car owners to list their vehicle on the platform, Drivy is empowering entrepreneurs to start a business of next generation car rental, as well as helping local car dealers and independent car hire companies to develop new revenue streams.

The organisation has several public-private shareholders, such as Nokia Growth Partner, Cathay Innovation, Index Ventures, Via ID, and BPI France. It also cooperates with local governments and Allianz Insurance.

One value proposition is that the company offers is that new members are offered training on how to get started. Car owners can rent their car out to other members, setting their own price. Drivy will also install a box that provides a GPS and makes the car connected. Car owners get to keep 70% of the rental amount, as Drivy keeps 15% and 15% goes to Allianz for insurance costs and roadside assistance costs. There is no subscription fee, and a deposit is not required. At the end, drivers can leave reviews of their experience, helping to ensure members are honest and fair.

### 3.3.2 Analysis of external factors

Figure below depicts an example of some of the existing interventions in Barcelona influencing the deployment of car sharing programmes:

Driver dimension	Examples of Barcelona - specific existing interventions and activities
POLITICAL	<ul style="list-style-type: none"> <li>Neither Spain at the national level, nor Barcelona at the local level, have a specific strategic plan for carsharing.</li> <li>In Barcelona's Sustainable Environment and the Metropolitan Area of Barcelona 2014-2020 (PSAMB), carsharing is proposed as an alternative to car ownership that can be beneficial for the environment (Ajuntament de Barcelona, 2014).</li> </ul>
LEGAL	<ul style="list-style-type: none"> <li>Currently, in Barcelona there is no legal instrument regulating the market or the use of car sharing.</li> </ul>
ECONOMIC	<ul style="list-style-type: none"> <li>Barcelona's metropolitan area has a population of around 5 million people, with a GDP per capita of € 42,000 (Barcelona City Council, 2017).</li> <li>Barcelona is the fifth most important region in Europe in terms of employment in the high-tech industry and the city is currently developing a 4.0 industrial sector based on Big Data (Barcelona City Council, 2017).</li> <li>Barcelona is one of the top ten cities in Europe for digital entrepreneurs and it is the fifth in start-up numbers (Barcelona City Council, 2017).</li> </ul>
SOCIAL & PUBLIC AWARENESS	<ul style="list-style-type: none"> <li>In December 2017, the City Council of Barcelona organized a citizen consultation for the development of the next Urban Mobility Plan. Citizen participation is perceived as crucial for the local administration.</li> <li>In Barcelona, the communication about the benefits of car sharing is led by operators. The local authorities have not yet carried out any sort of awareness campaign.</li> <li>Barcelona has a very strong cycling culture, in 2016 43% of the trips in the city were made by foot or by bicycle (Ajuntament de Barcelona, 2014).</li> </ul>
TECHNOLOGICAL/ INFRASTRUCTURE	<ul style="list-style-type: none"> <li>Barcelona counts with a relatively dense public transport. It has a metro grid of 119km, with eight lines of metro and 154 stations, from which 90% are accessible to people with disabilities. Barcelona's bus grid covers 4533KM, has 210 lines and 4565 stations, it offers a night service, a shuttle to the airport and a touristic bus (AMB Mobilitat, 2017).</li> <li>Between 2001 and 2011, number of registered passenger cars has decreased in Barcelona, especially during the economic crisis. It went from 611,807 in 2001 to 591,733 in 2011 (Ajuntament de Barcelona, 2014).</li> <li>Carsharing operators such as Avancar, have access to parking places in public areas dedicated to car sharing.</li> </ul>
ENVIRONMENTAL	<ul style="list-style-type: none"> <li>For years, the traffic of vehicles is the main source of air and noise pollution in Barcelona. In terms of air pollution, cars are the main emitters of nitrogen oxides and solid particles. Therefore, the City of Barcelona is committed to promote the use of electrical vehicles, the reduction of car use and to support the uptake of new mobility technologies or services to improve the environmental quality.</li> <li>In 2012, 4 from 7 air quality stations in Barcelona measured a higher presence of NO<sub>2</sub> emissions than the accepted annual limit. In 2018, the goal is to have all stations below the European parameters for NO<sub>2</sub> - PM<sub>10</sub> (Ajuntament de Barcelona, 2014).</li> <li>Barcelona strategic plans on air pollution and climate change, which are affecting the development of the mobility sector (Ajuntament de Barcelona, 2014).</li> </ul>

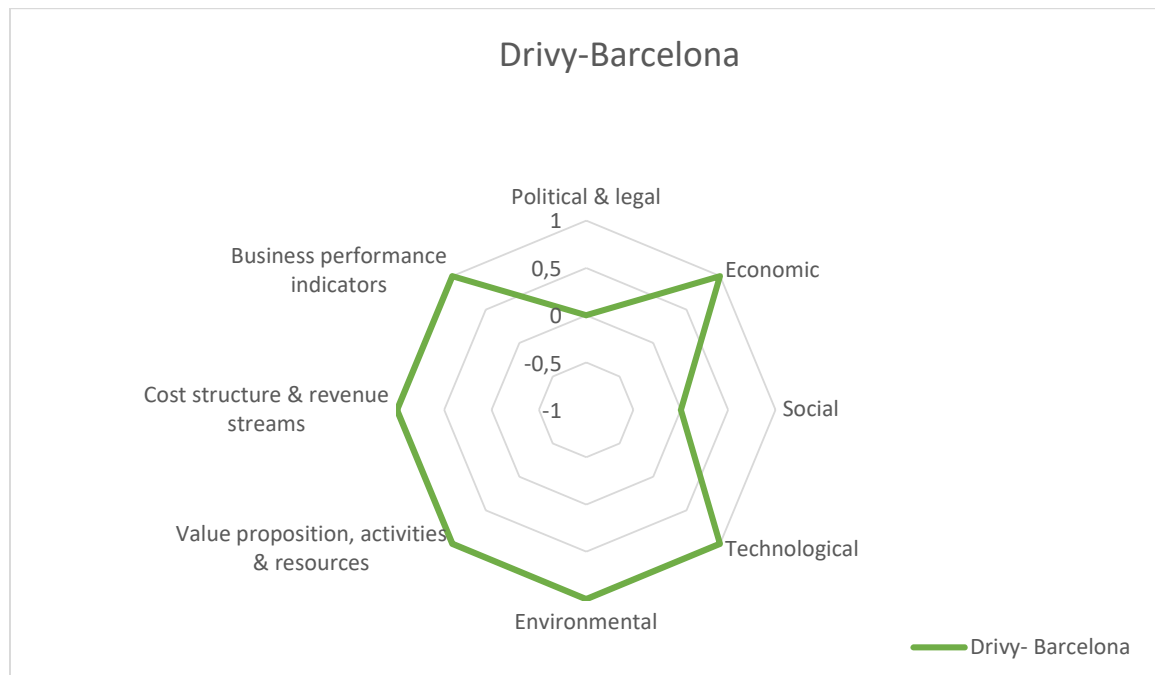
**Figure 45: External factors impacting Drivy in Barcelona**



### 3.3.3 Case 3 conclusion

The case study about Drivy in Barcelona, portrays the story of a dynamic start up in the mobility sector that choose Barcelona as a destination for internationalisation and market growth.

While Barcelona does not count with a legal and policy framework for car sharing, the city is home of many technology start-ups, a growing economy and a public administration willing to change the mobility sector to improve the environmental quality in the city.



**Figure 46: Drivy's use case assessment**

Although Drivy Barcelona is at the beginning of its history to assess its success or failure, it is clear that the business is increasingly attracting new customers as performance indicators reported. This may be explained by the fact that P2P business models tend to be for the longest trips distance-wise as reflects Drivy's strategy. Drivy's founder and Chief Executive Officer (CEO) Paulin Dementhon, and Drivy's Chief Development Officer Patrick Foster, commented in a separate interview online that the organisation focuses on trips lasting an average of two days, as ride-hailing services inside cities are more convenient than car sharing services, and therefore too competitive (Dementhon & Foster, 2018). In explaining how its prices are calculated, the French Drivy website lists time spans of one and two days, one week, and even one month (Drivy, n.d.). This strategy has proved to be a key factor of success in Barcelona, since it is the most visited city in Spain and many week end trips to the coast and the mountains are done.

Moreover, as Drivy does not have to provide a vehicle fleet or stations, this business model alleviates upfront costs. This also enables lower-density suburbs of Barcelona and smaller towns in the coast to partake in car sharing as well (Hampshire & Gaites, 2014; momo, 2009).

## INSIGHTS AND CONCLUSIONS

Car sharing has huge potential to improve quality of life and traffic conditions in cities. It offers a car at your disposal without the need of ownership and has the potential to reduce the number of cars in cities without reducing individual mobility. The wide spread of information and communication devices (smartphones in particular) and of social media and web platforms, together with the sharing economy that is growing into a cultural consumption approach, are at the basis of this development. Moreover, smart technology has helped to improve the experience of using car sharing, making booking, accessing and using shared transport easier.

While car sharing in recent years has witnessed double-digit growth, particularly in bigger cities where the costs of owning a car can be more easily offset, only a small percentage of people actually use it when compared to other urban modes. This leaves a gap, meaning that cities are unable to reap the full benefits of car sharing.

**With this in mind, the STARS partners set out to better capture the underlying forces that affect car sharing. In fact, D2.2 of the STARS project focuses on a number of aspects to understand how mobility sharing practices are influenced by the arrival of digital technologies, automotive advances, the emergence of social innovation patterns and mobility behaviour and choices.**

Looking at the challenges European cities face, it is clear that Europe needs to acknowledge the potential of car sharing in its policy papers and recommendations for urban mobility measures. This includes looking at both ICT based innovations and the inclusion of autonomous transport systems, their impacts on the urban mobility environment and the related infrastructure needed.

While automatic car sharing systems already started in 90's with the installation of the first onboard computer and GPS standards, IoT holds a great promise enhancing fleet maintenance. Indeed, functionalities such as easier real-time journey planning and parking place availability check will improve the shared mobility experience of users. On a longer term, blockchain is pointed out to shape peer-to-peer car sharing, potentially changing the roles of intermediaries, facilitating financial transactions and developing transparent usage-based insurances. Finally, big data analytics will help car sharing operators enhance fleet management, by analysing information on the idle times of vehicles for particular areas in the city.

The arrival of driverless autonomous vehicles, on the other hand, represents a unique opportunity for fundamental change in urban mobility. However, a path based mainly on individual ownership of autonomous cars would not exploit the potential of AVs for sustainable transport but could lead to an increase of vehicle mileage without reducing car ownership and related space consumption. According to UITP, AVs will only help to reduce the number of cars (reduce car ownership, car traffic and parking needs) and drastically improve mobility options, if they come as shared fleets integrated with public transport.

As automotive advances are reshaping the driving experience - turning drivers into passengers and pulling users at the centre of the mobility ecosystem – people's values, norms and attitudes towards shared mobility are changing significantly with the rapid spread of smartphones and new practices of sharing economy. Therefore, new predictors of travel mode choice, including technological and social innovations, are highlighted in the present study to explore the attitude-behaviour gap related to mobility choices. While D2.2 intends to give some insights on the travel attitudes and choices, it should be noted that the overall importance of individual, social, political, environmental and economic variables in driving the behavioural change towards shared mobility will be studied in WP4<sup>38</sup>.

Furthermore, and on the basis of our research to understand the relationship between car sharing diffusion, socioeconomic factors and web 2.0 (Chapter 2), the following conclusions emerged:

**First**, it is really difficult to state consistent correlations between the car sharing growth and the variables analysed, especially comparing different countries. This is essentially due to the fact that the diffusion of car sharing is still a niche phenomenon compared to other structural changes in European societies related e.g. to demography, car ownership patterns or mobility behaviours. Nevertheless, the methodology of study here presented might be implemented in the future, when car sharing is likely to be more spread. Despite such limitation, comparing trends in different countries related to car sharing diffusion and a range of other factors can be informative.

In particular, in the UK the uniform growth of the car sharing is more proportional to trends related to socioeconomic factors, while the exponential growth of car sharing seen in Italy and Germany in more recent years is not related to demographic and income trends. In the latter case, such growth is in fact probably due to the roll-out of large car sharing industrial operators about five to seven years ago.

Concerning mobility habits, there is some evidence that the diffusion of car sharing in some countries like Italy might have been facilitated by larger disruptions of mobility habits due to the economic crisis starting from 2008, compared to other countries like the UK where a more static situation is observed. At city level, some cities have a strong penetration of CS in terms of number of members compared to others which have even more CS vehicles (e.g. Rome).

Car sharing market and online (Web 2.0) services have experienced significant growth in Europe in recent years, as shown in Chapter 2. In Italy for example, for every increase in the participation level in social networks, an increase in the number of shared cars can be seen. Whether the participation level (independent variable) has a direct impact on the growth of car sharing, and more specifically on the number of shared cars (dependent variable), can't be concluded from this analysis. There might be other related variables influencing on this relationship too. Therefore, we cannot make any

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<sup>38</sup> <http://stars-h2020.eu/project-organisation/>  
GA n°769513



statement about this on the basis of our research since there might be other variables influencing its evolution.

**Second**, the actual localisation of car sharing services needs to be taken into account: due to data availability, we compared country-level characteristics with the national growth of car sharing, but car sharing developments are probably much more related to local conditions (the CS national trend is based on data of few cities).

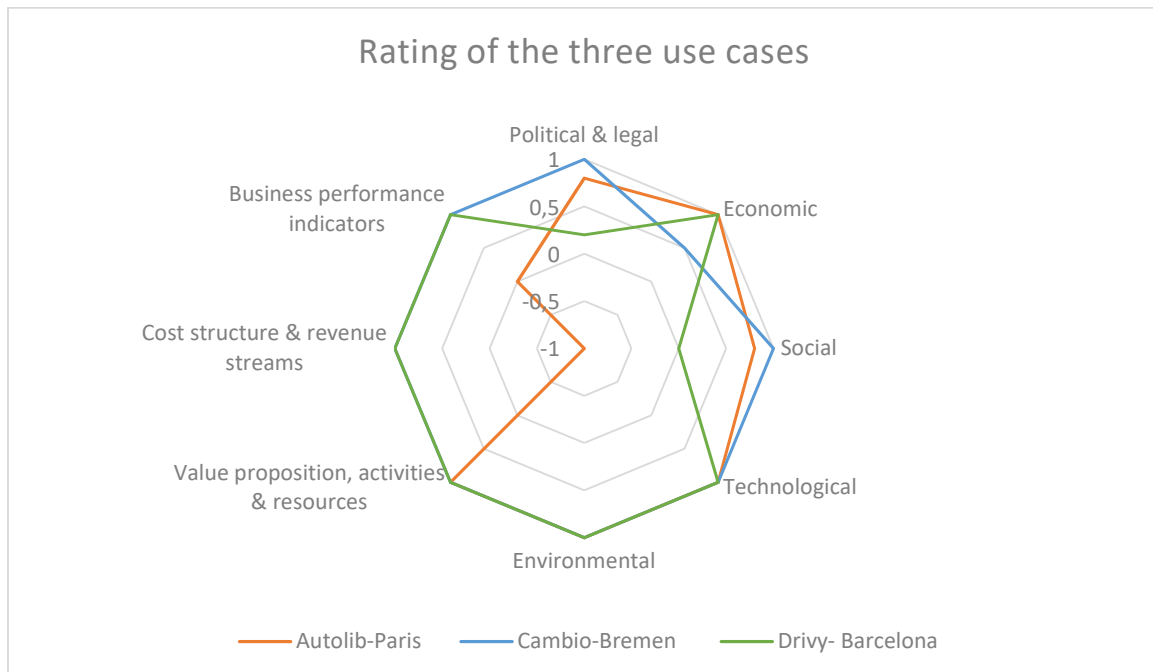
**Third**, the scope of the analysis was limited to available data and time constraints. As such, a follow-up study could look into other variables (not available yet) that could be more useful to understand car sharing mobility practices, including the number of trips done with car sharing vehicles and the car replacement rate. The latter could be of especial interest for municipalities and urban planners as it describes how many cars are either replaced by previous car owners when becoming customer of a car sharing service or not purchased (as otherwise when not having a car sharing service).

**Lastly**, a specific analysis of three use cases was carried out in with the objective of studying the main drivers, barriers and KPI's to deploy car sharing in urban areas. In Paris, Autolib was chosen as an example of a private-public electrical car fleet that operates as free floating with pool stations. In Bremen, Cambio provides a successful example of a round trip station-based car sharing operator that counts with the continuous support of the local government. And in Barcelona, Drivy offers an example of peer-to-peer car sharing start up that chose Barcelona as one of its internationalisation destination. Following the methodology presented in Chapter 3, three use cases were analysed from two perspectives. In one hand, the internal factors related to the car sharing operators' business model and business performance were considered. And on the other hand, the external factors shaping the urban mobility sector were taken into consideration. Table 9 presents a summary of the use cases' assessment against internal and external factors, conditioning, to an extent, the success or failure of operations.

Rating of external and internal factors			
	<b>Autolib-Paris</b>	<b>Cambio-Bremen</b>	<b>Drivy-Barcelona</b>
<b>Political &amp; legal</b>	<ul style="list-style-type: none"> <li>★ The concept of car sharing has been introduced in the French Law.</li> <li>★ Many policies and incentives were created to support car sharing. <ul style="list-style-type: none"> <li>★ SUMP</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>★ City plan for car sharing <ul style="list-style-type: none"> <li>★ SUMP</li> </ul> </li> <li>★ There is a legal statement at National level</li> </ul>	<ul style="list-style-type: none"> <li>★ No specific strategic plan for car sharing</li> <li>★ In Barcelona's SUMP 2014-2020 car sharing is proposed.</li> <li>★ No legal instrument on car sharing.</li> </ul>
<b>Economic</b>	<ul style="list-style-type: none"> <li>★ Paris is a leading economy in Europe.</li> <li>★ Paris is home to thousands of start-ups and to a dynamic mobility ecosystem.</li> </ul>	<ul style="list-style-type: none"> <li>★ Growing economy and increasingly dynamic business environment.</li> </ul>	<ul style="list-style-type: none"> <li>★ Very dynamic economy and high entrepreneurial culture.</li> <li>★ Barcelona is one of the top ten city's in Europe for digital entrepreneurs and is also a leader in high-tech employment.</li> </ul>
<b>Social</b>	<ul style="list-style-type: none"> <li>★ High awareness due to many communication campaigns.</li> <li>★ Enthusiasm towards new mobility technologies and services.</li> </ul>	<ul style="list-style-type: none"> <li>★ Car sharing is present in Bremen since a long time and has become part of the local culture.</li> <li>★ Communication campaigns launched as part of the car sharing action plan</li> </ul>	<ul style="list-style-type: none"> <li>★ Strong cycling culture but lack of awareness about car sharing.</li> </ul>
<b>Technological</b>	<ul style="list-style-type: none"> <li>★ Paris has one of the densest public transport network in the world.</li> <li>★ Paris counts with booming mobility market and a rich and diverse ecosystem.</li> <li>★ Car sharing parking in public areas.</li> </ul>	<ul style="list-style-type: none"> <li>★ Multi modal transport offer.</li> <li>★ Car sharing parking in public areas.</li> <li>★ Car sharing is part of new real estate development projects.</li> </ul>	<ul style="list-style-type: none"> <li>★ Barcelona counts with a relatively dense public transport.</li> <li>★ Car sharing parking in public areas.</li> </ul>

<b>Environmental</b>	<ul style="list-style-type: none"> <li>★ Paris has an Environmental Plan that sets targets for the mobility sector.</li> </ul>	<ul style="list-style-type: none"> <li>★ National CO<sub>2</sub> targets.</li> <li>★ “Sustainable Urban Planning” working group.</li> <li>★ SUMP</li> </ul>	<ul style="list-style-type: none"> <li>★ Barcelona’s strategic plans on air pollution and climate change are affecting the development of the mobility sector.</li> </ul>
<b>Value proposition, activities &amp; resources</b>	<ul style="list-style-type: none"> <li>★ High level of satisfaction.</li> <li>★ Practical and attractive.</li> </ul>	<ul style="list-style-type: none"> <li>★ Practical and attractive.</li> <li>★ Increasingly, an alternative to car ownership.</li> </ul>	<ul style="list-style-type: none"> <li>★ Attractive and practical offer for people who don’t have a car.</li> </ul>
<b>Cost structure &amp; revenue streams</b>	<ul style="list-style-type: none"> <li>★ BM not profitable</li> </ul>	<ul style="list-style-type: none"> <li>★ Balanced business plan with no exponential economic revenues.</li> </ul>	<ul style="list-style-type: none"> <li>★ Exponential growth in different cities in Europe.</li> <li>★ Growing economic benefits.</li> </ul>
<b>Business performance indicators</b>	<ul style="list-style-type: none"> <li>★ Steady business development</li> <li>★ Rating: 0</li> </ul>	<ul style="list-style-type: none"> <li>★ Steady business development</li> <li>★ Increasing number of users</li> </ul>	<ul style="list-style-type: none"> <li>★ Exponential business development</li> </ul>

**Table 9: Rating of use cases’ external and internal factors**



**Figure 47: Autolib, Cambio and Drivy’s use case assessment**

It is worth stressing that this study has shed light on the drivers and challenges that car sharing operators face, both from a business model and city level perspective. Indeed, based on the operator's strategy, different impact levels have been highlighted.

Autolib, as a free floating with pool stations scheme, allows members to take one-way trips and then park the car at a number of charging stations that have ideal locations around Paris. Their strategy is to offer a service that is complementary with public transport, making multi-modal transport easier. According to customers, it has proved successful since it really offers Parisians a more flexible alternative to go from A to B (compared to public transport). However, despite being the world's largest free-floating with pool stations organisation (in terms of vehicle fleet size and the number of subscribers), Autolib continues to postpone its date of financial profitability. Despite the economic model, two drivers are identified for deploying this strategy; First, the density of the city, since it implies a greater number of potential users in the vicinity of each station, which makes it possible to provide a large number of stations, thus a large number of potential journeys. Second, a favourable urban context with a clear necessity of flexible multimodal services and a local authority with a clear shared mobility strategy (and willing to support economically this type of service). These factors question the replicability of this business model for less densely populated areas.

On the other hand, Cambio, as a round trip station-based car sharing scheme, allows members to choose a car from a station and then return it to the same station when they are done. With its wide variety of vehicles and the reliability of pre-reservation (but also the option of spontaneous bookings), their strategy is to offer an alternative to private cars and therefore it has a much higher impact on car ownership than does free-floating car sharing schemes. Three drivers are identified for deploying this type of strategy; First, car sharing is not a stand-alone measure but is embedded into overall urban development and transport strategies. This implies that car sharing stations are integrated into neighbourhood parking management, new urban developments and public transport. Second, a great effort of communication and awareness needs to be done from the city to educate users on reducing car ownership; and third, a mixed modal split with a strong cycling/walking culture.

And Drivy, as a peer-to-peer car sharing startup, allows its users to rent other people's cars within walking distance of home whenever they need one. Unlike its counterparts, Drivy does not try to capture drivers who need to take short trips inside a city – their strategy focuses instead on having repeat customers, and drivers who are in need of a car for longer trips. As Drivy does not have to provide a vehicle fleet or stations, this business model alleviates upfront costs. Three drivers are identified for deploying this type of strategy; First, to have a good platform; Second, to have credible shareholders and good partnerships with insurance companies; and third, communication effort to capture key customer segments.

Finally, it is worth stressing that being aware of the combination of factors shaping the conditions for car sharing operations in a given city is crucial. Only by acknowledging that internal and external factor that can condition the success or failure of new mobility services, policy makers, businesses and associations can estimate the existing barriers or incentives for transforming the mobility sector. As such, a follow-up study could assess the same business model deployed in two different cities (one big city and a less densely populated one).

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## APPENDIX 1

The literature search was conducted from January 2018 to February 2018. The search query was made in the databases ProQuest and Scopus, in the fields title, abstract and keywords. The filters limited the search to: peer reviewed scientific articles, with full text, in English and published between 2008 and 2018. The keywords were separated in two levels as follows:

- ★ ((ridesharing application) OR (social media)) AND
- ★ ((sharing mobility) OR (Mobility-as-a-Service) OR (car sharing) OR (ridesharing) OR (carpool\*))

The objective of the literature review was to identify **studies that had investigated the use of application and social media in the context of shared mobility**. A list of 106 papers was generated and after the application of selection criteria, 22 papers were selected for the review. The selection criteria were that use of application should be mentioned as object of study or at least as a factor considered in the context of shared mobility. Following is the list of relevant studies and descriptions of the main investigation.

Citation	Description
(Abrahamse & Keall, 2012)	Effectiveness of a carpool use ride-matching software
(Buliung, Bui, & Lanyon, 2012)	Study of workers engagement with an internet-based carpool formation software
(Birdsall, 2014)	Car sharing description and categorization
(Anderson, 2014)	Comparison of for-profit ridesharing using smartphones applications to traditional taxicab and ridesharing models
(Firnkorner & Muller, 2015)	Experiment with users of car2go with the use of smartphones in different electrification-scenario
(Shaheen & Bansal, 2015)	Awareness and perception of P2P car sharing
(Anderson, 2016)	The insertion of smartphones as social interfaces between drivers and passengers



(Toader, Sprumont, Faye, Popescu, & Viti, 2017)	Potential of geospatial big data for travel behaviour analysis
(Zhu, So, & Hudson, 2017)	Consumers motivation to adopt ridesharing application
(Jittrapirom et al., 2017)	Define of MaaS attributes through a literature review, which is then used to describe selected MaaS schemes and existing applications.
(Payyanadan, Gibson, Chiou, Ghazizadeh, & Lee, 2017)	Driving challenges faced by older drivers and a guide the development of a customized web-based trip-planning tool.
(Almeida, Silva, & Leite, 2017)	Development of a decision support system that simplifies the process of choosing car sharing services.
(Willing, Brandt, & Neumann, 2017)	Business model of multimodal mobility platforms (MMPs) and provide an overview of currently active solutions.
(Masoud & Jayakrishnan, 2017)	Algorithm proposal for ridesharing system
(Vodopivec & Miller-Hooks, 2017)	Stochastic optimization
(Bistaffa, Farinelli, Chalkiadakis, & Ramchurn, 2017)	System solutions
(Tremblay, 2016)	Sub-market in platform marketplaces
(Siddiqi & Buliung, 2013)	Historical review of ridesharing with changes in information and communication technologies (ICTs)
(Bruck, Incerti, Iori, & Vignoli, 2017)	Web application development to organize carpooling
(Barchiesi, Preis, Bishop, & Moat, 2015)	Large-scale human mobility patterns through uploaded images in Flickr website
(Siuhi & Mwakalonge, 2016)	Review of opportunities and challenges of the applications related to transportation
(Erdoğan, Cirillo, & Tremblay, 2015)	Web application as a predictor of ridesharing

**Table 10: Studies identified in the literature review that investigate web application in transport scenarios.**

## APPENDIX 2

### Car sharing data

France: "Enquête Nationale sur l'Autopartage – Edition 2016" (ADEME, 2017)

Germany: "Car sharing-Städteranking 2017" available on the Bundesverband Car sharing e.V. website (<https://carsharing.de/>)

[http://www.cities-for-mobility.net/documents/wc11/michael\\_glotz\\_richter.pdf](http://www.cities-for-mobility.net/documents/wc11/michael_glotz_richter.pdf)

<https://www.slideshare.net/shareNL/sharenl-symposium-autodelen-2016-michael-glotzrichter-why-cities-should-embrace-car-sharing>

Italy: "1° Rapporto Nazionale – La sharing mobility in Italia: Numeri, fatti e potenzialità" (Fondazione per lo sviluppo sostenibile, 2016)

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### Population

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## Cars

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## Modal split

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<http://www.epomm.eu/>  
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## Web 2.0

[http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc\\_ci\\_ac\\_i&lang](http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_ci_ac_i&lang)

## Longitudinal analysis:

Scatterplots of historical data, which put in relation two variables considering their absolute values: this is useful to understand if trends of different variables have common patterns, and if such patterns are different when considering different countries or cities.

Trend plots of historical data, which put in relation two variables considering their variation from a reference value: this is useful to fix scaling issues, i.e. when the data of one of the two variables or both assume very different values which can compromise a good interpretation of the information.

**Cross-sectional analysis:**

Scatterplots of couples of variables where each point represents the situation in a given country or city: this kind of representation considers the information referred to a specific year but in different areas, revealing clusters of areas where car sharing is relatively more or less diffused compared to some other variable.