STARS

Shared mobility opporTunities And challenges foR European citieS

Research and Innovation action

H2020-MG-2016-2017

Review of the Impacts on the Automobility Market

Deliverable D3.2

Version n° 2

Authors: Peter Wells (CU), Haokun Liu (CU), Suzi Maurice (LGI), Esti Sanvicente (LGI), Stefano Beccaria (GM)

www.stars-h2020.eu

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

DISCLAIMER

The content of this deliverable reflects only the author's view. The European Commission and INEA are not responsible for any use that may be made of the information it contains.

Document Information

Grant Agreement	769513
Project Title	Shared mobility opporTunities And challenges foR European citieS
Project Acronym	STARS
Project Start Date	01 October 2017
Related work package	WP 3
Related task(s)	Task 3.2
Lead Organisation	CU
Submission date	30 JUNE 2018
Dissemination Level	Public

History

Date	Submitted by	Reviewed by	Version (Notes)
08 June 2018	CU	Paul Nieuwenhuis	D32_08062018
		Marco Diana	D32_08062018
		Ben Waller	D32_08062018
		Johannes Rodenbach	D32_08062018

Table of Content

List of Tables

List of Figures

Acronyms

AAQ	European Ambient Air Quality
ACEA	European Automotive Manufacturers' Association
AFV	Alternative Fuel Vehicle
BEV	Battery Electric Vehicle
CC	Congestion Charging
CCZ	Congestion Charging Zone
DfT	Department for Transport
EEA	European Economic Area
LEZ	Low Emission Zone
LPG	Liquid Petroleum Gas
OEM	Original Equipment Manufacturer
PM	Particulate Matter
ULEZ	Ultra-Low Emission Zone
VAT	Value-Added Taxes
VM	Vehicle Manufacturer

Executive Summary

- Car sharing schemes are a minor part of the EU market for new cars at present
- There is no material impact on the volume of new car sales in the EU arising from car sharing
- Car sharing schemes 'compete' with new cars, used cars, other modes such as electric bicycles, ride sharing, taxi services, traditional rental cars, and with public transport
- Bike sharing schemes are growing very quickly across the EU, and may displace some car sharing opportunities
- Car sharing offers an additional route to market for vehicle manufacturers, and may be used as another source of 'nearly new' cars for remarketing systems
- Car sharing schemes tend to use smaller and lower-specification vehicles compared with the market average
- The larger fleets are dominated by vehicle manufacturers and daily rental companies
- But also car sharing schemes on average have 10% of the fleet as EVs, much higher than the market average
- The failure of the Autolib scheme in Paris has raised doubts about the viability of large public initiatives
- The consolidation of DriveNow with Car2Go suggests the large private initiatives have also struggled for viability
- Car sharing profitability depends upon the trade-off between capacity utilisation and subscription numbers
- Other business models appear to be more durable, notably the smaller schemes embedded in enthusiastic communities
- Schemes also work better when integrated into urban transport planning as part of a cohesive approach to mobility
- Recent concerns over urban air quality and diesel emissions may support future car sharing scheme growth
- Quality of urban life concerns also support car sharing in the quest for 'liveable cities'
- The large free-floating station schemes (e.g. Autolib) have major challenges in capacity utilisation, the location and maintenance of stations, and management costs in repositioning vehicles
- The round-trip station schemes (e.g. Greenwheels) have limitations, but also a lower cost business model that has assisted in durability.
- The peer-to-peer model schemes (e.g. Drivy) have expanded rapidly in terms of the number of people registered as members but offer little benefit for urban transport concerns.
- Free-floating area schemes can work within relatively defined small areas where specific parking provision (e.g. for an EV) is not required
- Larger free-floating area schemes (e.g. DriveNow) need scale to be effective, which has not yet been fully achieved

1 Introduction

In this report the focus is on the relationship between car sharing and the wider market. The overall market for new and used cars shapes the opportunities for car sharing in, for example, the type of vehicles available. Alternatively, car sharing may impact upon the scale and character of the market with, for example, some potential reduction in the sale of new cars and the ownership of cars arising from the activities of car sharing clubs and businesses.

The report starts with an overview on the market for new cars in the EU, as this provides the overall context within which car sharing has become established. The report in Section 2 covers the scale and character of the new car market, with some description of the differences between countries and of the main trends influencing the market. Car sharing is also related to overall vehicles in use. Indeed, one significant motivation for urban authorities to embrace and encourage car sharing is that growing levels of vehicle ownership per capita are placing increasing stress on the available infrastructure, and on the environmental quality of urban areas. In reality, car sharing activities may also 'compete' with the used car market. That is to say, an individual may contemplate the choice between joining a car sharing scheme, or buying and owning a used car at considerably lower cost than a new car.

The report provides a discussion in Section 3 of the prevailing 'routes to market' for new cars, of which car sharing is one. The impact of car sharing on the overall market and on the industry is somewhat conditional upon these routes to market, and to the extent to which car sharing might resemble one or more of those routes. Providing firm empirical evidence on these various routes is problematic, as the data are not collected with this in mind or in an appropriate form. However, the matter has been discussed with industry experts who have verified the principle routes and their characteristics as discussed in the report. This idea is elaborated further in Sections 4 and 5 of the report when consideration is given to the impact of car sharing on the market overall, and the scope for the main business model types identified for car sharing arising out of WP 2 and WP 3.1. Section 3 goes on to consider briefly the implications of car sharing for the long-term character of the market for cars and for car use. These considerations include the extent to which automobility dependence has been 'hard wired' into lifestyles over a very long period of time as both a form of cultural embedding and as a practical reality with the spatial separation of household activities.

In Section 4 there is an analysis of the relationships between car sharing and other aspects of mobility, particularly but not exclusively in urban areas. It is pertinent to consider, for example, whether the rapid growth of bicycle sharing schemes complements or competes with car sharing. Many public transit operations now seek to integrate car sharing, particularly with respect to short-

distance travel to and from the public transit hub. There are a great many structural changes underway around key activities such as shopping, the implications of which in terms of car sharing are uncertain. However the report highlights such key issues as urban logistics and online shopping because they speak to the reasons why individuals may choose to travel.

Finally in Section 5 the report analyses the scope for growth in car sharing, principally by examining the five business model types identified in 3.1. It is apparent that the prospects for car sharing are not evenly distributed across the EU, and that some markets and localities have been more enthusiastic than others in embracing car sharing concepts. What is less clear is why these differences should emerge and whether there are policy actions available that could enable greater penetration of car sharing in those localities that have so far proven rather resistant.

2 Impacts of car-sharing on the EU automobile market

2.1 Context: Trends in the EU automotive market

2.1.1 Anti-diesel sentiment across the EU

According to ACEA's (European Automobile Manufacturers' Association) report (2018a), petrol vehicles have become the most popular sold car types in EU car registrations in 2017, and it was the first time that petrol vehicles surpassed the number of diesel vehicles since 2009. About 45% of all EU-15 passenger car registrations are diesel cars, compared to petrol vehicles, which account for 50% of new passenger car sales (Fig.1).

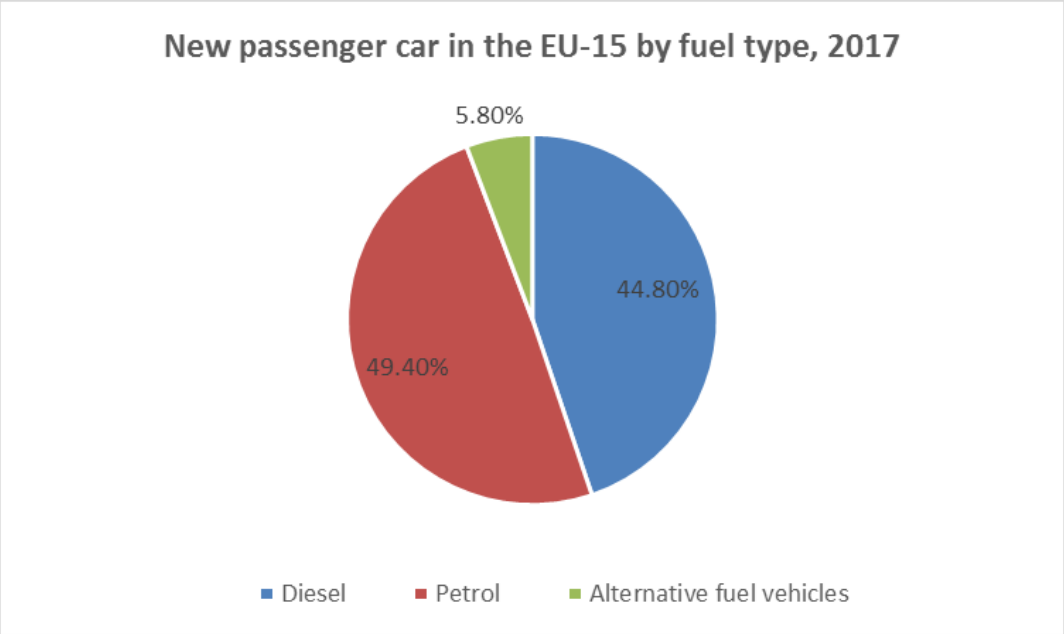


Figure 1 New passenger car registrations (Source: ACEA, 2017a)

Due to the "anti-diesel sentiment", the market share of diesel car sales has fallen back to 2003 levels, as more customers switch back to petrol vehicles rather than cleaner diesel vehicles (Experteye, 2017). In France, diesel car market share has fallen from 52% in 2016 to 47% in 2017. Similarly in Germany, diesel new car sales has fallen from 45.9% in to 38.8% in 2017. In conclusion, anti-diesel sentiment in Europe is the cause of decreasing diesel car sales, as show in Fig. 2, but there is also a need to call for policies to support the transition towards a more sustainable transport mode.

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

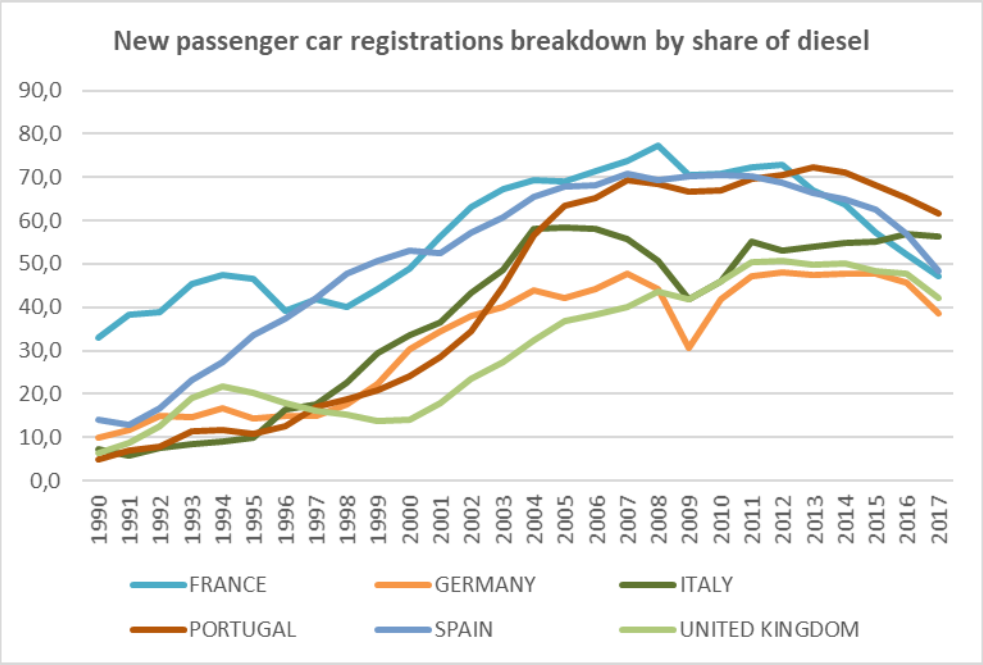


Figure 2. New passenger car registrations breakdown by share of diesel (source: ACEA, 2017b)

2.1.2 CO_2 emissions and air quality

On the other hand, there is an increase in registrations of petrol cars in the EU-15, the average CO_2 emissions of new car registrations has gone up by 0.4% to 118.5g/km in 2017 (EEA, 2018). A factor here has been the popularity of so-called 'cross over' vehicles (a segment typified by the Nissan Qashqai). This segment has grown at the expense of the market share of medium and smaller cars, and hence tended to push up average fuel consumption and CO_2 emissions. With regards to major markets, there is an increase in the United Kingdom (+0.8%), France (+0.6%), Spain (+0.5%) and Germany (+0.1%).Also, the significant increase can be found in Poland (+1.43%) and the Netherlands (+2.27%) respectively (ACEA, 2018). This is the first record as an increase in CO_2 emissions of new passenger car registrations, since the monitoring started under the EU legislation from 2010.

2.1.2.1 Air quality in European major cities

There is little doubt that concerns over urban air quality have increased with time in the European Union, in part as an understanding of the health effects of diesel emissions and other sources of pollution have become more clearly understood. The estimation of the health impact of poor air quality, and the contribution of cars to overall air quality is subject to many epidemiological assumptions. According to the European Environment Agency (EEA, 2017) in 2012 there were 403,000 premature deaths attributable to particulate (PM2.5) air pollution in the EU 28. In addition, the EEA estimated for the EU 28 a further 16,000 premature deaths due to low-level ozone (O_3) and 72,000 to NO_2.

It by now established that many European cities exceed the limits defined by the EU for pollution, and the publicity that accompanies these pollution episodes has helped to mobilise public opinion and the desire for policy action, as has the possibility of punitive measures from the European Union on those urban authorities whose cities regularly exceed safety limits. Moreover, the European Environment Agency has established a website in which the real-time air quality of many cities and towns across the EU can be seen (see the data in https://www.eea.europa.eu/themes/air/air-quality-index/index). By 2015, more than 200 urban areas across 12 EU countries had some form of low emission zone defined (Holman et al., 2015).

Cars are not the only source of poor air quality in urban areas. As Degraeuwe et al. (2017) discuss, much depends upon the city under consideration. As a consequence, measures to improve the quality of the diesel car fleet such as banning all cars that lack Euro 6 Type Approval may be more effective in, say, London or Paris compared with Athens or Krakow. Similarly, as Ferrero et al. (2016) show, the impact of increasing the proportion of the fleet using electric powertrain is also variable, although in general the use of such vehicles will result in air quality improvements (Hooftman et al., 2016). The creation of low emissions zones may not readily result in measurable improvements in air quality (Holman et al., 2015), but as the zones become larger, more stringent, and complemented by traffic reduction measures then the effectiveness is likely to increase.

Overall, the net consequence of the discourse that has emerged around cars, urban air pollution and health has been to reinforce the arguments of those who wish to see a significant reduction in car ownership and use. In turn such arguments mean that the attractiveness of car sharing as a contributor to the resolution of urban air quality concerns is increased. An additional factor in favour of car sharing is that there is a higher proportion of electric cars in these shared fleets, and the contribution of zero emissions at point of use is significant in improving local air quality.

2.1.3 Urban governance in the EU's major cities

Urban areas provide a large majority of EU citizens of the space for living, daily mobility and transport infrastructure. Around 73% of EU citizens were living in urban areas in 2010, and this trend will lead to an increase to over 80% by 2050 (European Commission, 2017). Urban mobility is responsible for about 40% of all CO_2 emissions of road transport according to European Commission, and it is also crucial for sustainable urban mobility because of the associated rise of congestion, poor air quality and noise pollution.

The major cities have relied on demand-side regulations in order to manage the local traffic quality and quantity, which can be also called as access regulations. For local government, access

regulations can be briefly divided into four categories: low emission zones (LEZ), parking policies, congestion charging (CC) and limited traffic zones (European Commission, 2017), as shown in Table 1. The following are the major cities with these access-related regulations.

City	Type of restriction	Vehicle affected	Discounts/exemptions for AFVs	Launch date
Amsterdam	LEZ	Mopeds, taxi, tour buses	N/A	Jan 2018
Brussel	LEZ	Car, vans<3.5t, (tour) buses	Electric vehicles with a Belgian licence plate are allowed to enter the LEZs without registration and for free	Jan 2018
Lisbon	LEZ	All vehicles		July 2011
London	CC, T-charge, LEZ	All vehicles for CC, All four wheeled motorised vehicles do not meet Euro 4 for T-charge, Diesel-engine commercial cars for LEZ	Electric vehicles have 100% discount for CC	Feb 2003 (CC), Oct 2017 (T-charge), Feb 2008 (LEZ)
Milan	CC	All vehicles	Electric vehicles, hybrid, natural gas, LPG and bi-fuel vehicles have 100% discount. Exemption for people with disabilities, subjected to life-saving treatments	Jan 2012 (from 2008 to 2011 it was Pollution Charge, “Ecopass”)
Munich	LEZ	All diesel vehicles, and petrol vehicles without a closed loop catalytic converter	N/A	October 2012
Paris	LEZ	All vehicles	N/A	July 2017
Stockholm	CC	All vehicles	Certain cleaner fuelled vehicles registered between Jan 2009 to Aug 2012 have exemptions	Aug 2007

Table 1. Urban regulations and measurements in the EU (Adapted from Transport& Environment, 2018; Urban Access Regulations in Europe, 2018)

2.1.3.1 London

The congestion fee in London has been charged from 2003, and it aims to reduce high traffic volume and traffic pollution in London’s central area. The congestion charging scheme is applied to a majority of vehicles from 7:00 to 18:00 on the working days, and the scheme has

added another emissions surcharge (which is also called 'T-Charge') since 2017, it aims to charge the vehicles that do not meet the Euro 4 emissions standard. According to the report from Transport for London's (TfL) (Transport for London, 2017), public transport contributed around 45% of journey stages in London, compared with 32% by private transport. The result shows the trend that there is a shift from private transport mode to a well-established public transport in London(Fig. 3).

Another access-related regulation in London has been introduced as a low emission zone (LEZ). In 2008, the TfL introduced the LEZ in order to reduce the tailpipe emissions from diesel-powered commercial cars in London. The LEZ operates 24 hours a day, 7 days a week, and it covers most of Greater London based on the signs at the boundary. Moreover, the world's first Ultra-Low Emission Zone (ULEZ) will be introduced by TfL from 2019, and the ULEZ will cover as the current Congestion Charing Zone (CCZ) and operate 24 hours to replace the current T-Charge (Mayor of London, 2017). It is worth noting that the ULEZ will impact on more vehicles (up to 60,000 every day)- diesel vehicles that do not meet the Euro 6 standards and petrol vehicles that do not meet the Euro 4 standard-in order to tackle air pollution in central London.

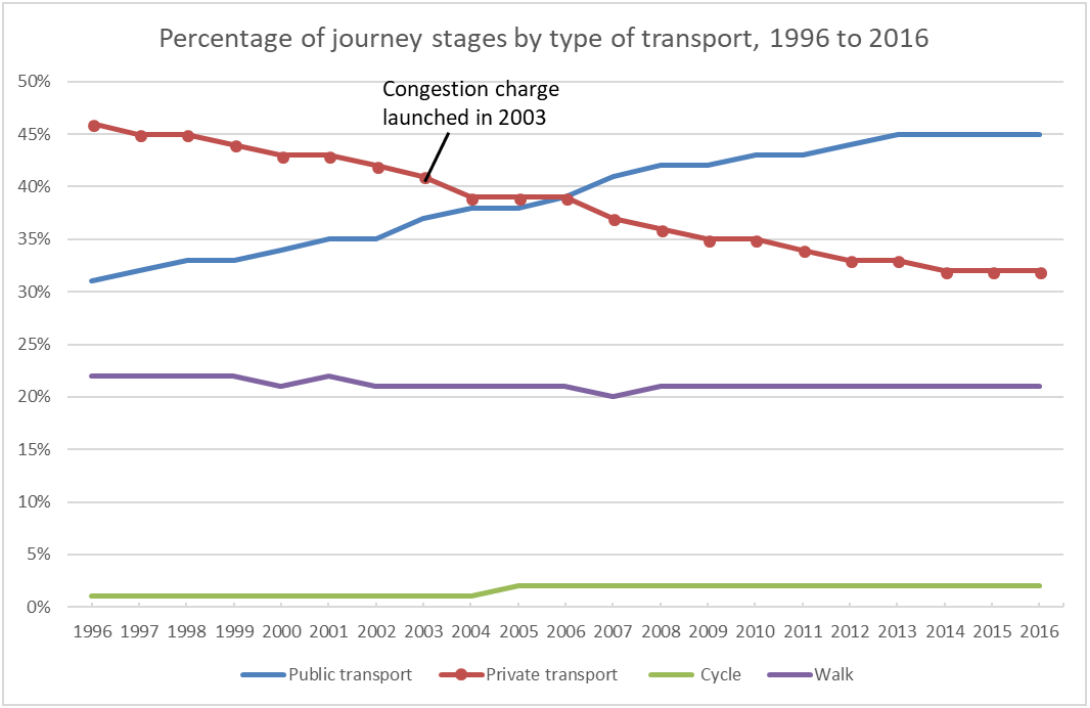


Figure 3. Percentage of journey stages by type of transport, London (Source: TfL, 2017)

2.1.3.2 Munich

Munich launched its low emission zone in 2008, and vehicles can only get access to the zone based on their emissions groups. Three coloured stickers have been given to all vehicle that drive into the city centre according to the emission levels: red for emissions group 2; yellow for emission group 3; and green for emissions group 4. Initially, Munich allowed all types of

environmental badges (red, yellow, and green) to get into the city centre from October 2008 to October 2010. From October 2010 to October 2012, a stricter emission standard has been introduced that only allowed yellow and green badges. Finally, from October 2012 till now, only green badges are allowed to enter Munich. According to the study of sources of ambient particles before (2006-2007) and after (2009-2010) the implementation of LEZ in Munich, Qadir et al. (2013) found that the contribution of traffic sources factors has decreased about 60%.

2.1.3.3 Amsterdam

Amsterdam has introduced a Low Emission Zone from 9th October 2008 in order to strive for reducing the concentrated local air pollution. After the trial period from October 2008 to January 2009, heavy-duty vehicles that were classified as Euro 0, I and II, have been prohibited from the LEZ. The regulation has been tightened since January 2010, all Euro III vehicles that without a diesel particulate filter have also been prohibited from the LEZ (Panteliadis et al., 2014). Interestingly, moped use is getting more and more popular in Amsterdam during this period. According to the research from Royal HaskoningDHV, mopeds have increased by 11% from 2016 to 2017. However, mopeds contributed to 2%-23% ultrafine particles on cycle paths and 40% ultrafine particles in tunnels (Regterschot, 2017). Therefore, Amsterdam has introduced a LEZ for mopeds, taxis and tour buses since January 2018. At the same time, the minimum wage group will receive a subsidy when purchasing a bike, e-bike or e-scooter. The overall aim of Amsterdam is to become as much zero-emission city as possibly by 2025.

After the implementation of a LEZ in Amsterdam, Boogaard et al. (2012) conducted research towards five Dutch cities that launched the LEZ (Amsterdam, The Hague, Den Bosch, Tilburg and Utrecht). The result showed that the LEZ policies did not substantially change concentrations of traffic-related pollutants along the streets. However, another study in 2014 showed that there was a significant decrease in air pollution concentrations after introducing a LEZ for heavy-duty vehicles in Amsterdam (Panteliadis et al. 2014).

2.1.3.4 Milan

The city of Milan introduced in 2008 a cordon pricing scheme in the city center, in order to reduce both congestion and air pollution. The scheme, called "Ecopass", was in force until the end of 2011. In January 2012 it was replaced by a congestion charge scheme, called "Area C" (Croci & Ravazzi Douvan, February 2016). The access to the historical centre of Milan is limited by the "Area

C" on Monday, Tuesday, Wednesday and Friday from 7.30 to 19.30, and Thursday from 7.30 to 18. To get into "Area C" you must activate an entrance ticket of 5 euro[1].

"Area C" is bounded by "Cerchia dei Bastioni", with 43 cameras-monitored access points, including 7 for exclusive use of public transport.

According to a comparative road pricing study (Croci & Ravazzi Douvan, February 2016), as a consequence of Ecopass and Area C restrictions, the traffic inside the tolled area as of 30 June 2011 was reduced by 16,2% with respect to 2007, before the Ecopass was implemented. In 2012, after the launch of Area C, the traffic reduction has been even greater, corresponding to a further reduction of 30,1% with respect to Ecopass last year (2011). Road accidents within the tolled area were reduced by 21,3% in the period 2007-2011 and a further reduction of 23,8% in 2012 registered, with respect to 2011. Yhe traffic composition in the tolled area improved as the number of most polluting vehicles decreased by 70% by 2011 with respect to base year 2007.

The public transport use, measured as the number of passengers exiting subway stations inside the tolled area, increased by 12,5%. In addition, the average speed of public transport increased by 11,8%. It is estimated that the Ecopass scheme reduced the area's total PM10 emissions by 15% compared to the prior period without the Ecopass. These estimated PM10 emissions were reduced by another 18% after the first year of the Area C toll system in 2012 compared to 2011 levels.

2.1.3.5 Paris

A sticker called Certificats qualité de l'air (Crit'Air) has been introduced for all vehicles that want to enter the Low Emission Zone in Paris from 2017. The implementation of a LEZ can be divided into two phases: phase 1 is from January 2017, all vehicles should be at least Crit'Air sticker 5; phase 2 is from July 2017, all vehicles should be at least a Crit'Air sticker 4. Paris' LEZ is a relative low-ambition policy at the beginning, but the Euro standards will be tightened gradually in the future. Also, investigations and experiments have been conducted in different places in order to introduce more limited traffic zones or other access-related regulations.

[1] http://www.comune.milano.it/wps/portal/ist/it/servizi/mobilita/Area_C/cosa_area_c

2.1.4 Impacts on car-sharing practice

The focus of this section is to describe the current state of European automotive sector and the potential opportunities for car-sharing practice, especially in response to the congestion and air pollution in the urban area. From this stage, we can find that there is a growing pressure on local authorities to reduce congestion and cut emission from the high pollutions, where national action has been missing and passing to local government (Transport & Environment, 2018). As shown in Fig. 4, the urban access regulations in Europe mainly rely on the following methods: congestion charge, restriction on heavy goods vehicles, and low emission zone. Initially, these regulations' focus is on the reduction of traffic congestion. With the increasing awareness of traffic pollution in urban areas, the European Ambient Air Quality (AAQ) Directive has been set up in 2008 in order to require all member states to carry out the measurements of local air quality (Bondarouk and Liefferink, 2017). Many European cities have been regulating air pollution in order to face the challenge. At the same time, these urban access regulations have encouraged the public transport modes and shifted the way of daily commuting to a more sustainable transport. At the same time, alternative and innovative transport modes, for example, electric carsharing, ridehailing and bike sharing practices have had opportunities to develop across the European cities, and these practices may also have an impact on the current carsharing market.

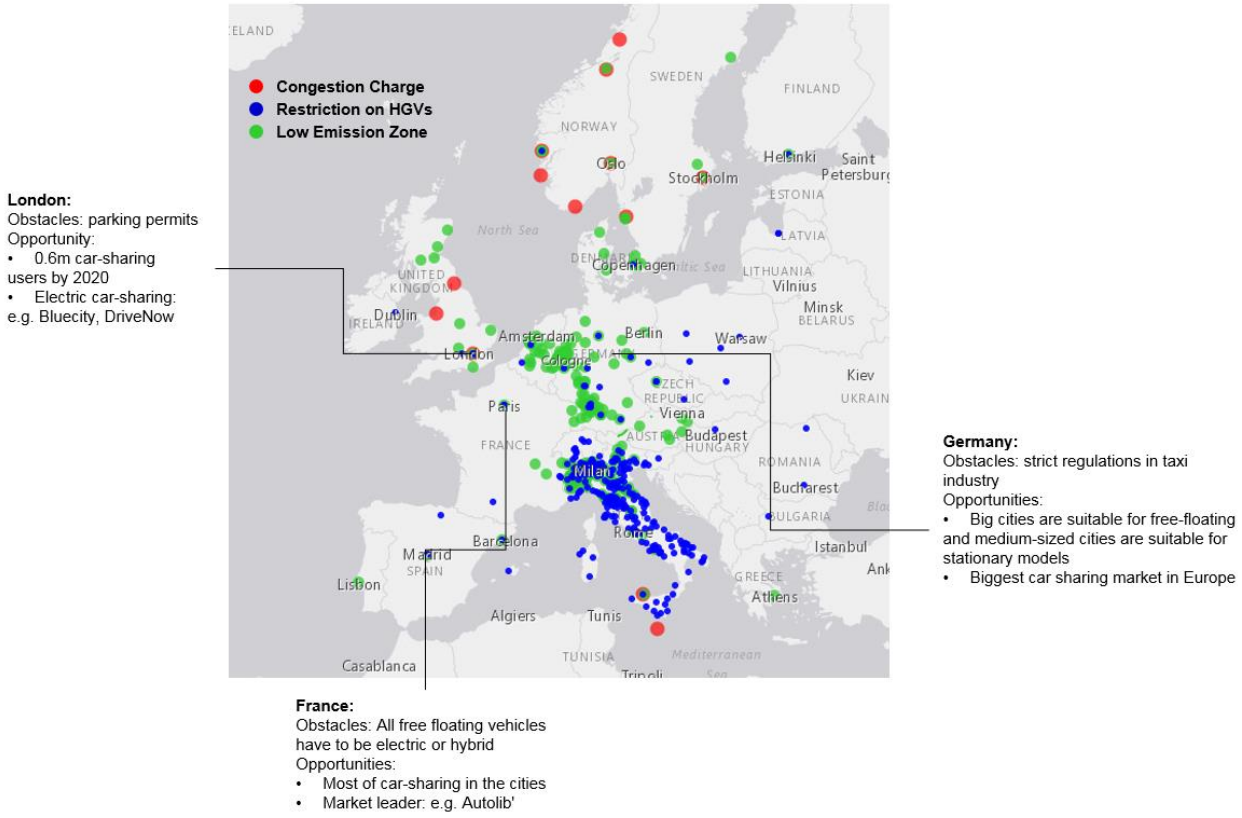


Figure 4. European carsharing landscape (Adapted from Transport & Environment, 2018; Urban Access Regulations in Europe, 2018)

2.1.4.1 Electric vehicles

In this section, battery electric vehicles (BEVs) are selected to illustrate the current stage of EV registrations in the EU. Overall, the registrations of BEVs are proved to be the strongest growth during the past 5 years, total registrations have risen from 24,586 in 2013 to 97571 in 2017 (Fig. 5). However, when looking at the market share of alternative fuel vehicles (AFVs), a limited role of AFVs can be found due to the fact that the electrically chargeable mode only accounts for only 1.4% of the total registrations (ACEA, 2018b).

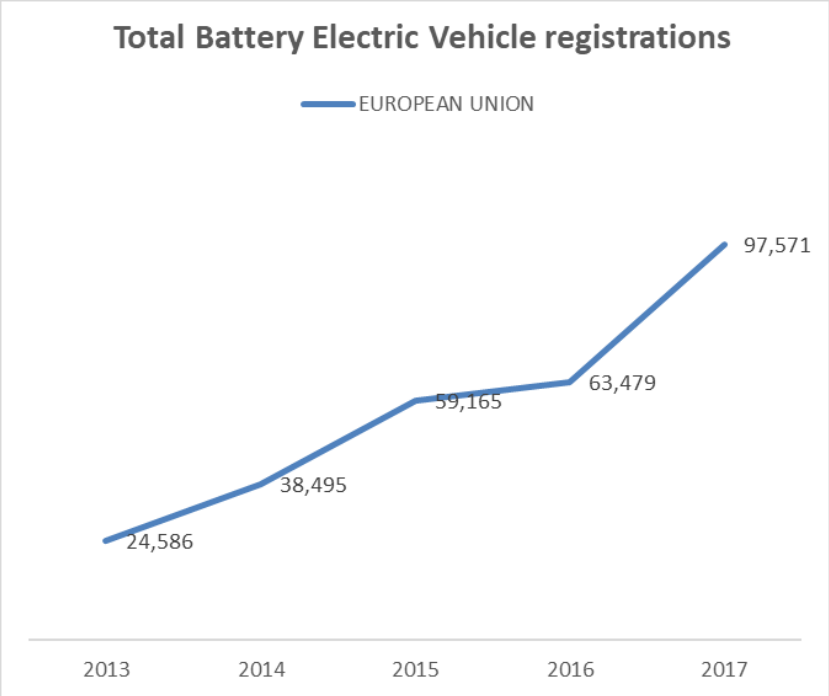


Figure 5. Total battery electric vehicle registrations (Source: ACEA, 2018c)

Tax exemption for electric vehicles is the most important measure for the introduction of clean transport mode, because clean technologies are always more expensive than the conventional ones with respect to the customer's acceptance and economy of scale. Therefore, there is a need for a positive policy in order to keep the policy consistency across the EU. Table 2 shows the overview of tax incentives for EVs (ACEA, 2018d), five major countries are selected to give a general picture of the tax measures in the EU.

Country	Tax incentives
FRANCE	Regions have the option to provide an exemption from the registration tax (either total or 50%) for alternative fuel vehicles (i.e. electric, hybrids, CNG, LPG, and E85). Electric vehicles and vehicles emitting less than 60g CO2/km are not subject to the tax on company cars. Electric and hybrid electric vehicles emitting 20 g/km or less of CO 2 benefit from a premium of €6,000 under a bonus-malus scheme. An incentive scheme grants an extra €4,000 for switching an eleven year or more diesel vehicle for a new BEV (or €2,500 in case it's a PHEV).
GERMANY	Electric vehicles are exempt from the annual circulation tax for a period of ten years from the date of their first registration. From July 2016, the government granted an environmental bonus of € 4,000 for pure electric and fuel - cell vehicles and € 3,000 for plug - in hybrid and range - extended electric vehicles.
ITALY	Electric vehicles are exempt from the annual circulation tax (ownership tax) for a period of five years from the date of the first registration. After this five-year period, they benefit from a 75% reduction of the tax rate applied to the equivalent petrol vehicles
SPAIN	Main city councils (e.g. Madrid, Barcelona, Zaragoza, Valencia etc) are reducing the annual circulation tax (ownership tax) for electric and fuel - efficient vehicles by 75%. Reductions are applied on company car taxation for pure electric and plugin hybrid vehicles (30%), and for hybrids, LPG and CNG vehicles (20%).
UNITED KINGDOM	From April 2018 until March 2021, cars that emit less than 50g/km qualify for 100% first year writing down allowances (FYAs). Zero emission vehicles attract a zero rate of vehicle excise duty (VED) Ultra - low emissions and electric vehicles pay reduced company car tax rates.

Table 2. Overview on tax incentives for electric vehicles in the EU (source: ACEA, 2018d)

2.1.4.2 Electric vehicle sharing and EV purchasing: Car2go as an example

Germany-based car2go is the world's largest electric fleets provider in the free-floating car sharing sector. With respect to the availability and distribution of charging infrastructure in urban areas, car2go CEO Olivier Reppert believed that purely electric car sharing fleets would provide the most suitable solution for the 'chicken-and-egg problem'. Car2go CEO Olivier Reppert said:

"We are convinced that the future of car sharing is electric." (Car2go, 2018)

Car2go has also listed the following five reasons that support his argument:

- Car sharing solves the chicken-and-egg problem regarding the development of a charging infrastructure
- Car sharing reduces people's reservations about using electric mobility
- Car2go proves electric mobility is suitable for high intensity usage-through the practical everyday operation of car sharing
- Purely electric car sharing improves the air quality in the cities-immediately
- Car sharing is the perfect testing ground and experimental field for electric mobility of the future

European automotive industry has been changing because of anti-diesel sentiment, electrification and autonomous technologies (Fulton et al., 2017). This trend also pushes car manufacturers to rethink their current product-centric strategy and to provide value added service to compensate the potential loss in car sales. Free-floating electric car sharing is likely to be an optimal solution to solve the problems raised by personal automobiles, because it consists of three parts: the shared ownership to reduce car usage (driving time is less than 1 hour), electric power train to cut off CO_2 emissions, and a free-floating nature that offers some degrees of flexibility (Firnkorn and Müller, 2015). According to a research on the relationship between car sharing service and private car purchase decisions (Firnkorn and Müller, 2015), the result showed that there is an increased willingness to give up purchasing private cars among the electric-car2go users. However, with the implementation of car2go business in several cities in Europe, there is a significant increase in the number of charging infrastructures and parking space for both their own business and other electric vehicles. In addition, station-based electric car sharing has similar advantages- shared ownership, electric power train, and maybe more comfort in terms of parking issue in urban areas.

2.1.4.3 (Electric) car sharing in European urban areas

Table 3 summarises the number of car sharing vehicles available in some specific cities in Europe. However, due to data availability, it is not able to find the precise number for all cities[2].. Some carsharing companies like DriveNow and Cambio have a mixed fleet of electric and conventional vehicles, so there is only a rough estimate of the number of electric cars that operate in car sharing business across these European cities, which accounts for 7,978 EVs. As shown in Table 3, Autolib electric vehicles account for 85% of the total car shared in Paris, and there are more than 1,600 shared BEVs on Madrid's streets.

Country	City	Tot n. Cars	Full EVs
Belgium	Antwerp	700	210
Belgium	Brussels	1,400	??
Belgium	Ghent	550	25
Bulgaria	Sofia	25	25
France	Paris	4,770	4,000
Germany	Berlin	3,311	??
Germany	Bremen	344	??
Germany	Cologne	1,347	??
Germany	Mannheim	233	??
Ireland	Dublin	325	??
Italy	Milan	3,290	788
Italy	Rome	2,200	530

[2] The red-coloured number and question mark in Table 3 show the data is either estimated or unavailable

Italy	Turin	900	150
Lithuania	Vilnius	500	??
Netherlands	Amsterdam	450	450
UK	London	2,516	200
Spain	Barcelona	365	??
Spain	Madrid	2,000	1,600
	Total	**25,226**	**7,978**

Table 3. Overview of electric car-sharing in European cities (Source: Vulog, 2018; Cambio, 2018; Automotive-fleet, 2017; Zhaw, 2018; Share-north, 2017; Carsharing, 2017; L'Osservatorio Nazionale Sharing Mobility, 2017; Citybee, 2018)

2.2 Context: Market regulation differences

With the many positive benefits of car sharing, many cities are now actively promoting its services, such as allowing members to have special parking privileges, or aligning car sharing programmes with public transport features (i.e. same key cards and payment platforms, interconnectedness with public transport hubs to enable multi-modality, etc.). City action is also being accompanied by national-level action. For instance, Italy encourages car scrappers to join car sharing programmes by covering their subscription fees to the national programme. It also offers benefits such as having the ability to access certain zones for free, or being able to cross yellow lanes on the roads while driving (Merella, 2008). Belgium, on the other hand, allows members of the P2P car sharing organisation CarAmigo to rent their personal cars out without having to claim their respective earnings as income (Ambani, 2015). Such benefits no doubt encourage citizens to take up car sharing memberships.

However, as with many sectors of the sharing economy, car sharing organisations face regulatory issues in the cities they serve across Europe. Critics of these new forms of the economy identify several concerns related to legal compliance, taxation minimisation, labour laws, regulatory frameworks, and adverse social or economic consequences. For instance, peer-to-peer platforms such as Airbnb are currently encountering challenges with safety and tax avoidance (Coldwell, 2014; Gelinas, 2015; Hickey and Cookney, 2016), and ride hailing services such as Uber are facing stiff opposition from taxi companies that claim such services constitute unfair competition (Gutiérrez, 2018).

For many car sharing organisations, however, their battle is often in the form of increased taxation. Despite local and sometimes even national government support for car sharing programmes, value-added taxes (VAT) tend to be higher for car sharing services than they are for nearly every other form of transport in the mobility sector. Such differential rates of taxation between car sharing and other modes of urban transport are coming into sharper focus as the number of mobility options available in cities starts to grow.

To develop perspective on this issue, Table 4 reviews the taxation rates on car sharing services in 8 countries in Europe, comparing them with five other different modes of transport in those same countries. The data is a compilation of various sources. For public transport and taxi services, official European Commission and national databases with VAT rates were consulted[3]. For newer forms of mobility, such as ride hailing and car sharing services, invoices of actual trips were used. As Uber is the most common ride hailing service across several European countries, its invoices are used to represent the rate that other ride hailing services must also pay.

	Public transport	Taxi	UBER	Car rental	Car sharing	Bike sharing
Belgium	6%	6%	6%	21%	21%	6%
France	10%	10%	10%	20%	20%	20%
Denmark	0%	0%	N/A	25%	25%	25%
Germany	7%	7%	7%	19%	19%	19%
Italy	10%	10%	N/A	22%	22%	22%
Poland	8%	8%	8%	23%	23%	23%
Portugal	6%	6%	6%	23%	23%	23%
Spain	10%	10%	10%	21%	21%	21%

Table 4. Comparison of VAT rates for competing forms of mobility across Europe

The table points to some interesting trends in Europe's mobility sector. Public transport, taxis and Uber all receive the lowest level of VAT in all of the countries studied. Car sharing, bike sharing, and car rental services often receive double, triple, or even 25 times the VAT rate to that of the first group. Among these, car sharing—and its greener sister bike sharing—is often treated the same as conventional car rental services. In other words, despite the efforts of many city planners and transport managers to promote new forms of mobility that are a part of the sharing economy, most car sharing and bike sharing users are still paying the same VAT rates as those who are using car rental services.

As bike sharing services are often restricted in terms of distance travelled and weather conditions, car sharing services are the closest competitor for taxi and Uber services, and are perhaps impacted even more greatly by the difference in VAT rates than bike sharing services. With 19% - 25% VAT for all car sharing services, many riders may choose to take a taxi or ride hailing service such as Uber, as this is not only more convenient, but the prices will reflect a diminished 6% - 10% VAT. Furthermore, due to the unique set of challenges that many car sharing business models face (see STARS deliverable 3.1), car sharing organisations may have greater difficulties in offsetting their VAT rate than other forms of mobility. Fig. 6, which offers a comparison of mobility

[3] VAT rates applied in the Member States of the European Union, 2018 https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf

prices for a trip taken across the city of Paris, highlights this challenge. Whereas a car rental service proved to be the cheapest option, at EUR 9-15, and a taxi cost EUR 20, Autolib, the city-supported electric car share programme, cost EUR 23 (Foucaud and Kermanach ,2011).

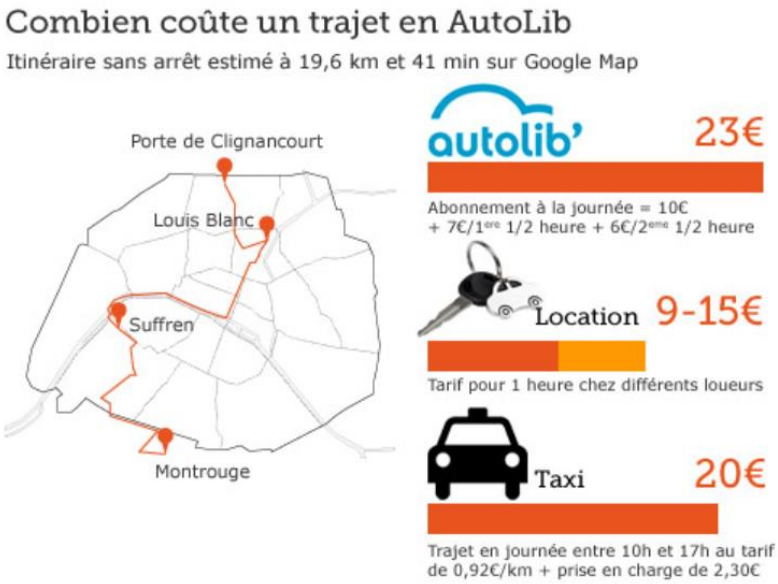


Figure 6. A comparison of prices for mobility options in Paris (source: Foucaud and Kermanach ,2011)

This is not to say that taxis are always the cheapest option, or that carsharing services are always the most expensive. Indeed, even with the higher VAT, some car rental or car sharing services may be cheaper than a taxi. To keep with Autolib, another source found that the programme cost drivers an average of EUR 1.13 per kilometre in 2016, compared with an average of EUR 2.40 per kilometre by taxi (Louvet and Jacquemain, 2017). However, it is important to keep in mind that the rate charged often depends upon conditions of the trip taken, such as the time of day, distance and geographic location of the starting and ending points. For Autolib, it is also important to note that the organisation has yet to become profitable (Louvet and Jacquemain, 2017), meaning its true costs are not represented in its price per kilometre. This makes it difficult to know by how much market regulations such as VAT rates could help the organisation.

In the United States, where car sharing organisations also face relatively higher tax rates than their counterparts, the future of the industry is uncertain (McCarthy, 2016). From mid-2014 to mid-2015, 12% of the car sharing vehicles on the road disappeared, dropping from 19,115 to 16,754 (Shaheen and Cohen, 2015). It should be noted that these figures did not include P2P vehicles, which are the personal cars of members. While Belgium is offering some tax benefits to

P2P car sharing members (Ambani, 2015), it is not yet the norm, nor is the P2P business model representative of the car sharing sector as a whole.

Regardless of the business model employed by car sharing organisations, more coherent taxation policies are needed across the sector, particularly with the rapid technological change that is taking place (Schwieterman and Spray, 2016). Should European cities hope to continue increasing their car sharing numbers, supporting their growth through more than parking and driving benefits, comparing the VAT levels that consumers must pay to other forms of mobility is called for.

It is also worth looking at market regulations in the bike sharing sector. In many countries, bike sharing receives similar VAT treatment to car sharing. The one exception is Belgium, where bike sharing services are given the same tax privileges as public transport, taxis, and Uber services. In 2016, Belgium's Ministry of Finance decided to recognise bike sharing services as a complement to public transport. On 1 January 2017, a trial policy came into effect, allowing all bike sharing services to be charged a reduced VAT of 6%, a rate equal to that of public transport (Institut des Experts-comptables et des Conseils fiscaux, 2016; Marckx, 2016). Belgium appears to be the only country taking such an approach, and it will be interesting to see if both this regulation and its P2P tax write-off spur growth of the corresponding services.

3 Scale and character of market for new passenger cars

Generally, there is no clear pattern with respect to the new passenger car registrations in western Europe. However, if the new passenger car registrations break down by segment and body, some trends can be revealed and could impact on car sharing market (Fig. 7). First, there is an increasing number of small cars sold during 1995-2017. Secondly, the registration of upper medium and executive cars have been increasing since 2009. In general, car sharing business is mainly based on small and medium-sized vehicles, so this trend could impact on European automotive market in the future.

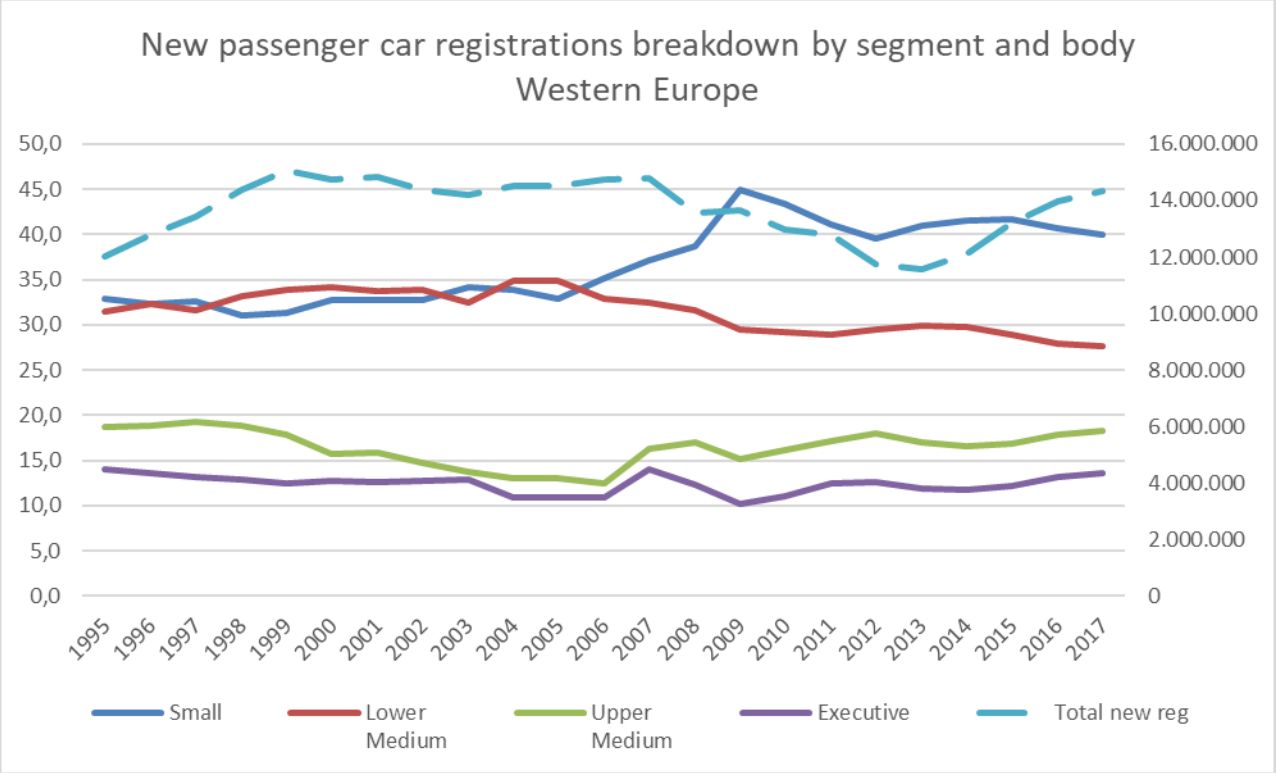


Figure 7. New passenger car registration in Western Europe (EU-15 + EFTA countries, source: ACEA, 2018e)

The new car registrations may vary with respect to different countries. For example, both private and company registrations have grown quickly during 2011-2017 in Great Britain (Fig. 8). However, in Germany, there is a decrease in the number of private car registrations, and it is worth note that the number of rental business registrations has been increasing during 2010-2016 (Fig. 9).

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

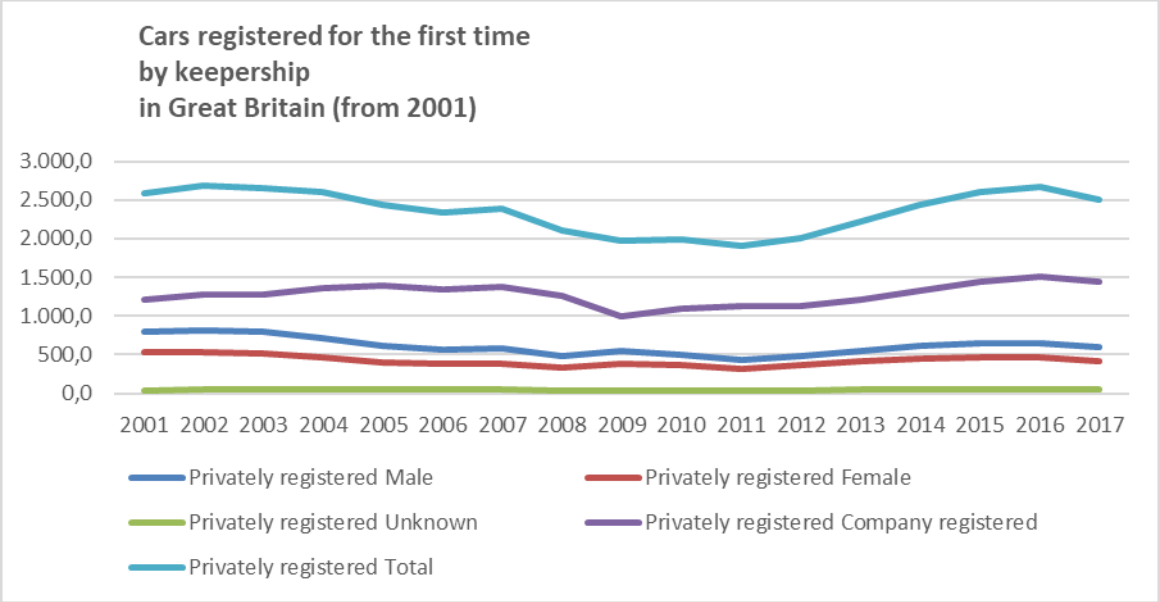


Figure 8. Car registrations for the first time by keepership in Great Britain (source: DfT, 2018)

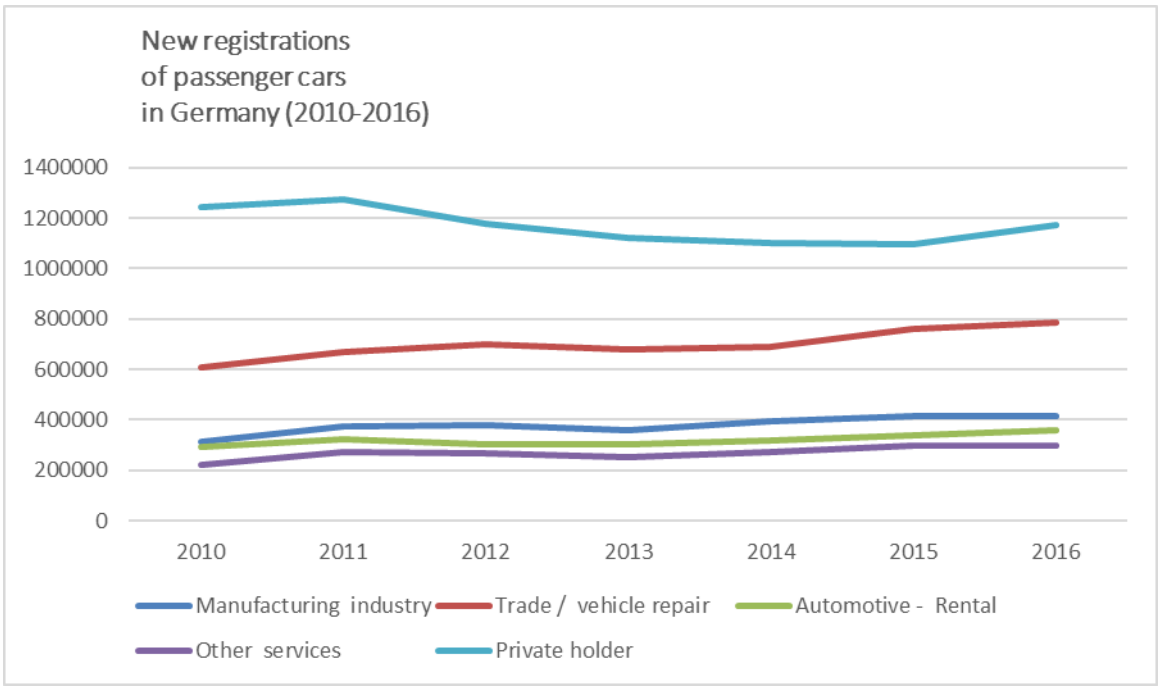


Figure 9. New registrations of passenger cars in the years 20010 to 2016 (Source: KBA, 2018)

3.1 Short term implications of the new passenger car market

3.1.1 Routes to market

There are multiple pathways or routes to market in between the vehicle leaving the factory and being in use in the market. These different routes vary widely across the EU depending upon multiple factors including the position and strategy of the vehicle manufacturer, the size and character of the various sub-markets to be accessed, the demand-supply position for individual

models and variants of models, and the relative capacity of the 'remarketing' structures for each manufacturer. These all vary with time, and with each market under consideration. Car sharing fleets may be considered as a new pathway or route to market with some distinct features depending upon the business model of the car sharing service in question. It is therefore pertinent to give some consideration to these routes to market, to understand the potential impact of car sharing on the market overall.

Marketing refers to the process of bringing a car to the first user, whereas remarketing refers to process whereby cars are returned from the first user and reintroduced to the market as 'used' or sometimes 'nearly new' cars. Often the cars return via 'approved used' schemes based in franchised dealerships (and manufacturer-owned dealerships) and are provided with extended warranty or guarantees, and subject to a series of point-by-point vehicle checks which may be carried out by a respected independent third party such as a motoring organisation. In the used car market it is the case that usually 'approved used' cars are, all other things being equal, more expensive than those sourced via an independent used car dealer, a used car auction, or direct from the previous user.

3.1.1.1 The different routes

Table 5 summarises the different routes to market. In so doing, the Table provides estimates of some of the important parameters associated with each route to market. These parameters have been discussed with industry experts and participants, but equally it must be understood that the parameters are guideline estimates only in what is a complex and dynamic situation. Indeed, the marketing and remarketing of cars is a constant process of adjustment in a bid to reconcile the relentless flow of the manufacturing system against the intermittent demands of the market.

Route	Market share	Discount rate	Ownership length	Return route
VM sale to management	5 – 10%	Up to 40%	6 – 12 months	1. Approved Used
VM sale to staff		Up to 35%	12 to 60 months	1. Approved Used 2. Independent auction and dealers
VM sale to suppliers		Up to 30%	36 months	1. Approved Used
VM marketing cars (National Sales Company)		Up to 40%	6 months	1. Approved Used
VM franchised dealers demonstrator cars	8 – 12%	Up to 40%	6 months	1. Approved Used

VM franchised dealers service cars		Up to 40%	12 – 36 months	1. Approved Used
VM franchised dealers pre-registered cars		Up to 40%	90 days	1. Approved Used
VM franchised dealers in-house rental cars		Up to 30%	12 – 36 months	1. Approved Used
Rental cars	8 – 10%	Up to 40%	6 – 12 months	1. Approved Used
Large fleets	10 -20%	Up to 30%	12 – 36 months	1. Approved Used 2. Independent auction and dealers
Small and medium fleets	10 – 15%	Up to 30%	36 – 60 months	1. Approved Used 2. Independent auction and dealers
User-chooser and 'grey' fleets	10 – 15%		36 – 60 months	2. Independent auction and dealers
'White' fleets and local authority; government agency, etc.	10 -15%		36 – 60 months	2. Independent auction and dealers
Special category e.g. Motoability in the UK	Up to 5%			
Retail customers	20 – 50%	0 - 15%	36 – 60 months	2. Independent auction and dealers
VM car sharing schemes including those run by franchised or owned dealerships	Less than 1%	Up to 30%	12 -36 months	1. Approved Used 2. Independent auction and dealers
Independent car sharing schemes	Less than 1%	0 - 15%	36 – 60 months	2. Independent auction and dealers

Table 5. The main routes to market (Discount rate refers to the reduction offered against official retail list price; VM = vehicle manufacturer).

It can be seen that potentially there are many routes to market, with varying rates of discount on official list price, varying holding periods, and different return routes.

A complicating factor in the above is the part played by finance and leasing companies, both owned by vehicle manufacturers and independent. They may act as intermediaries between the manufacturer and users, and typically retain ownership of the vehicle (and hence carry the asset risk), while passing the use of the vehicle on under various types of deal or arrangement. Typically, a leasing package will include the user paying a deposit (a % of original vehicle cost), and then a fixed monthly fee for a set duration (say 36 to 60 months) at a specified rate of interest. Conditions are attached, most notably there is usually a distance constraint of say 20,000 km per annum. On a pure lease, the vehicle is returned to the finance company, which then determines the disposal (remarketing) route.

There are divergent definitions of the 'business' or 'company' car depending upon the national market, and in turn much depends upon the fiscal regime in operation. Moreover, there is a distinction between 'job cars' and 'perk cars' with the former dominated by more utilitarian considerations.

The car sharing market is in many respects closest to the rental market in operational features. The rental market historically has consisted of three major elements: short-term holiday rentals (typically A/B size segments); short-term urban rentals (typically A/B size segments); and business rental (longer term up to 6 months, typically C/D size segments). It is notable that the vehicle manufacturers have often had direct ownership of rental companies in whole or in part, which is an illustration of the close nature of the relationship. It is also therefore notable that the biggest car sharing operations are owned by vehicle manufacturers.

Rental companies often enjoy high rates of discount because they order cars in substantial volume, and often take those cars that vehicle manufacturers are struggling to sell. Rental companies typically take cars either on risk i.e. bought outright and then left with the risk that on disposal the residual value will be lower than expected, or on agreed buyback i.e. at a lower buyback price but with a guaranteed return to the vehicle manufacturer who can then place the car into the used car remarketing system. Rental companies tend to hold cars for relatively short duration, often they are returned to the market before a first service is due.

Remarketing is important because it is an important determinant of ultimate residual value in a car, and hence has a bearing on finance provision and the true cost to the user / owner of the vehicle. Moreover, remarketing schemes seek to capture a high proportion of the most valuable of the returning vehicles, to enable greater revenues at the level of the dealerships. Those dealerships may themselves bolster the supply of used cars by pre-registration and the use of demonstrator vehicles or service vehicles. Dealerships face two basic pressures: they typically have a new car financed at zero interest by the in-house vehicle manufacturer finance operation for only 90 days, after which fees become payable. Hence it is a strong incentive to move a vehicle from the

forecourt stock. Second, there are often performance bonus payments from the vehicle manufacturer which may include the volume of new car sales in a specified period. Seeking to hit such target sales may incentivise the use of dealership 'sales' to itself.

3.1.1.2 The position of car sharing schemes

At present car sharing schemes are a residual fraction of the overall market, and probably in total less important than, say, the number of demonstrator vehicles registered per dealer across the EU.

There is no information on the rate of discount offered to car sharing operations, or the holding period for vehicles and their return route. As a working proposition we may say that the large, professional schemes typified by DriveNow the operation will have similarities to the car rental market for business users. Alternatively, the smaller 'grassroots' schemes probably function more like traditional retail purchasers.

Autolib is a special case in this regard, as there is no obvious route for used Autolib cars, and no established remarketing structure. The lack of popularity in terms of new car sales to retail customers does not bode very well for the eventual sale of used Autolib cars once their car sharing scheme lifetime has passed.

3.2 Long term implications of the new passenger car market

It is difficult for car sharing practice to have a great impact on the EU's automotive market in a short-term, for example, car sharing programs such as Car2go or DriveNow have a limited fleet size (14,000 cars for Car2go worldwide). Germany is considered as the most developed European car sharing market, roughly only 19,000 cars have been implemented in Germany (Fig. 10), and the number in Italy is around 7,000.

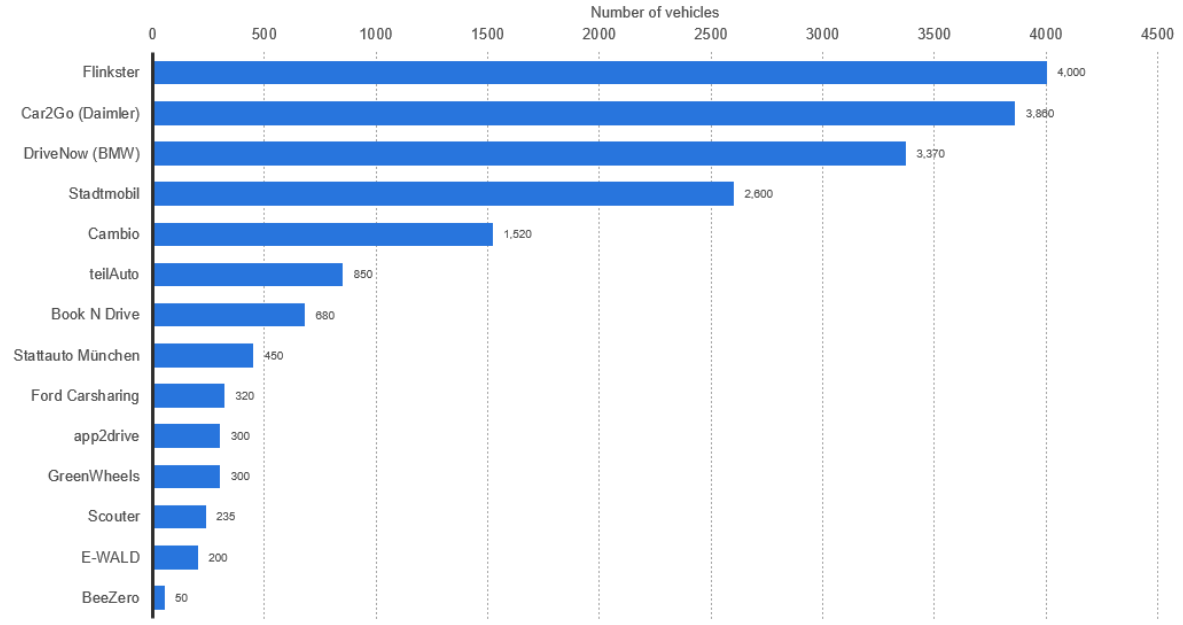
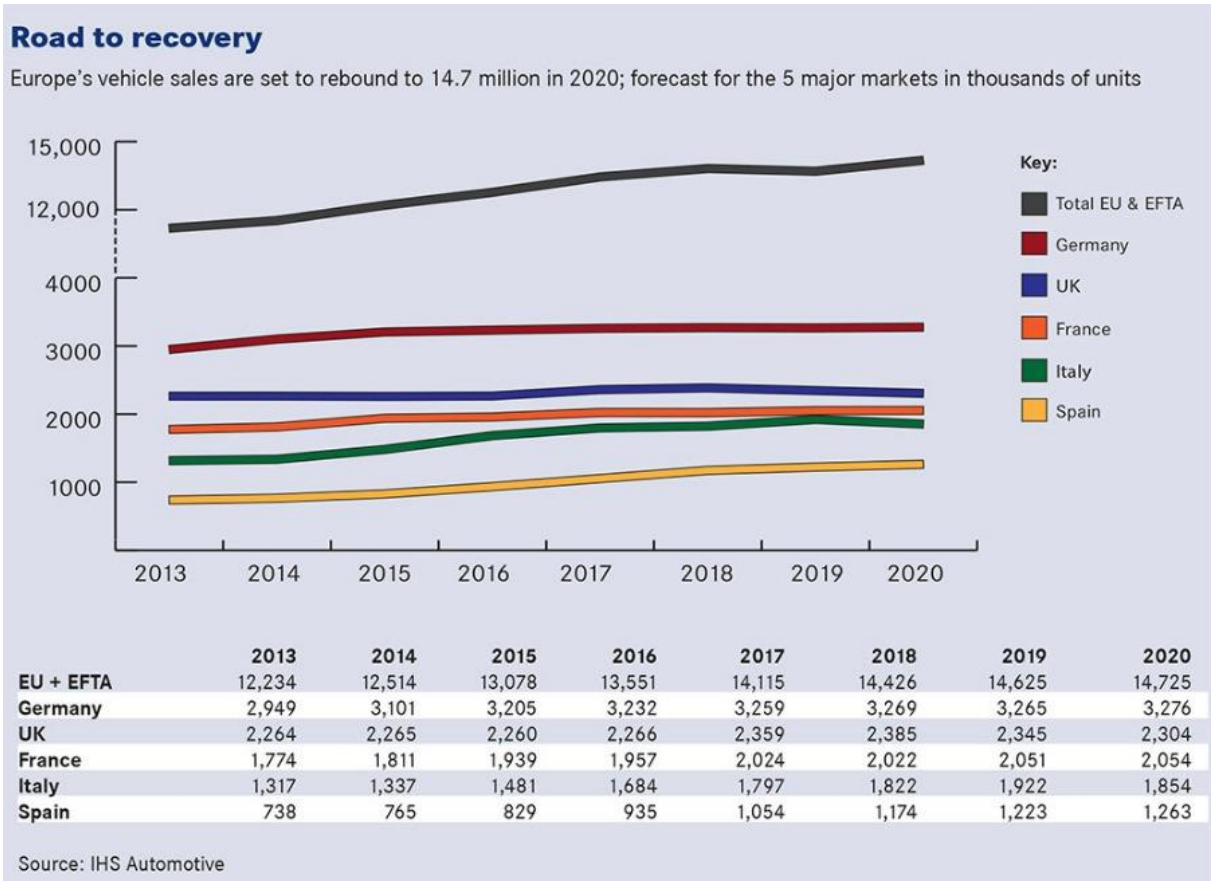


Figure 10. Leading car sharing services ranked by number of vehicles in Germany as of January 2018 (Source: Statista, 2018)

In Europe, passenger car sales are expected to grow from 14.1m (2017) to 14.7m by 2020 (Fig. 11). At the same time, P2P car sharing business such as Drivy still require a car owner by their definition. Therefore, a possible car sharing impact may be on dealers' network of the OEM, but a new form of car usage has been launched such as Book by Cadillac, Porsche Flex Drive, and Care by Volvo. These new business models can help dealers to become a more efficient and professional customer service, with new remarketing and after-sales services.



	2013	2014	2015	2016	2017	2018	2019	2020
EU + EFTA	12,234	12,514	13,078	13,551	14,115	14,426	14,625	14,725
Germany	2,949	3,101	3,205	3,232	3,259	3,269	3,265	3,276
UK	2,264	2,265	2,260	2,266	2,359	2,385	2,345	2,304
France	1,774	1,811	1,939	1,957	2,024	2,022	2,051	2,054
Italy	1,317	1,337	1,481	1,684	1,797	1,822	1,922	1,854
Spain	738	765	829	935	1,054	1,174	1,223	1,263

Source: IHS Automotive

Figure 11. Europe's vehicle sales forecasting (Source: IHS Automotive)

In addition, automotive market could be impacted by external factors which are not directly linked to car sharing. For example: ultra-compact vehicle (e.g. Twizy by Renault) or L-category vehicles, and all-inclusive mobility platform as per Daimer-BMW joint venture (Fig. 12)

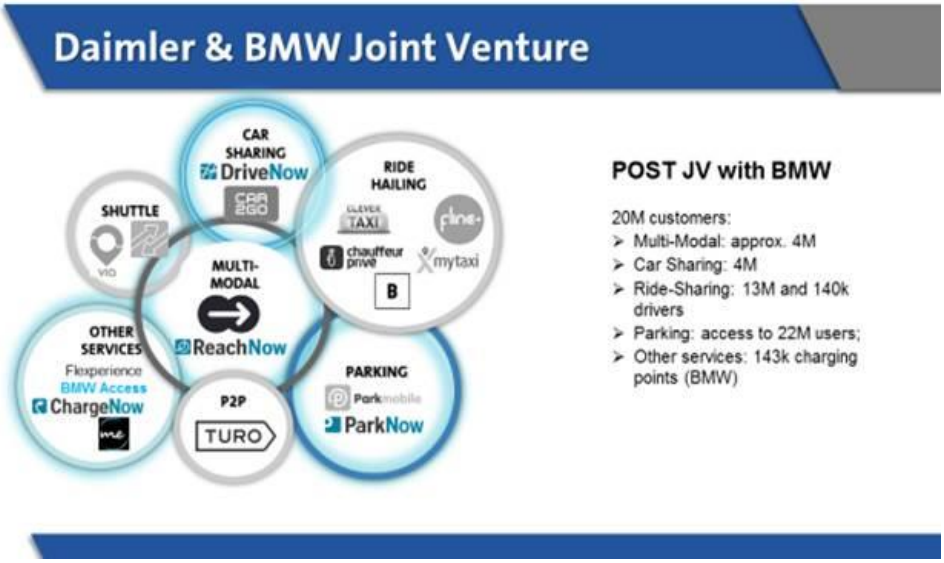


Figure 12. Daimler & BMW Joint Venture

With respect to the types of car used in free-floating and station based car sharing schemes, there is a range of vehicles from small city cars (Smart for two) to medium size cars (e.g. BMW Series 2 or Mini Clubman by DriveNow). In addition, EV providers such as Bolloré or Share n' go have implemented 4-seat-electric vehicles, which could also impact on the European automotive market in the long-term.

3.2.1 Retaining a population of drivers

A feature of car sharing in the context of 'peak car' discussions is that car sharing retains a population of qualified car drivers. Some peak car studies have highlighted that younger cohorts of the population do not have the same level of qualified car drivers than used to be the case (Kuhnimhof et al., 2012). That is to say, there is a smaller proportion of those under 25 or under 30 who are qualified to drive than used to be the case, particularly in urban areas.

The reduction in qualified drivers has been taken as a long-term structural shift that will eventually work its way through to reductions in purchases of new cars, reductions in the stock of cars in use, and overall reductions in dependence upon the car. This discussion is elaborated further below. Here it is sufficient to consider whether car sharing works in the opposite direction, by supporting a population of qualified car drivers.

Car sharing, as with other 'shared' modes such as ride hailing, must overall make car use continue to prevail as a mode of transport. While some short-term surveys show that car sharing individuals may abandon or not take up ownership of a car themselves, little is known about the long-term consequences. It is entirely possible, for example, that car sharing brings into car use a proportion of the population that would otherwise have struggled to achieve personal car ownership. Indeed, this is one of the main 'sells' of car sharing. By time-sharing a vehicle, users can retain the ability to drive cars and retain the ability to structure their lives around car use. In the longer term, as life circumstances change, perhaps they will be able to afford personal car ownership and use, or perhaps they will make lifestyle choices that dictate personal ownership and use. As the car sharing schemes develop there is an urgent need for more longitudinal data on those participating. There is scant information on the turnover of recruits to car sharing schemes and hence little insight into how far car sharing schemes inspire loyalty.

The data that is available from Autolib in Paris is not particularly encouraging (Louvet and Jacquemain, 2017). It suggests that if scheme members cannot find a car readily and easily they will abandon the scheme and use an alternative. In this regard, perhaps the car sharing schemes

themselves become the commodity once the 'higher' societal and environmental aspirations are lost.

3.2.2 Car sharing customer vs. new car purchasing profiles

A key concern for vehicle manufacturers arising from both technological developments (e.g. in electric vehicles, autonomous vehicles) has been to avoid commodification. In practice commodification can be understood to mean that the manufacturers no longer have a direct relationship with customers (via the dealerships) and that brand distinctions are eroded to the point where in most cases they are negligible). If the car becomes an amorphous blob, summoned at need when required and discarded equally casually, then much of the competitive edge created by vehicle manufacturers around their brands will disappear. One possible salvation for the established manufacturers is that their franchised dealers could seek differentiation of the mobility service offered while representing the brand, as the point of contact that manages the fleet and has close links to users. At present such dealer-based services are rather few compared with the independent schemes.

The pay-per-use model that tends to go with car sharing also tends to reinforce the perception of the car as a commodity. The focus of the different car sharing propositions tends to be on functionality, on the ability to meet a requirement, rather than the pleasure of the ownership of a material item or the sensations of movement conferred by the machine.

Purchasers of new cars are encouraged into discretionary spending on optional extras in isolation or in packages that are profitable for the vehicle manufacturers but may be of reduced utility to the purchasers. Such discretionary spending may be less evident in the world of car sharing, even though sometimes this type of spending can sustain residual values when the car is sold again as used. Car sharing cars tend to be in the smaller size segments with a 'utilitarian' focus compared with the average of new car purchases. Ultimately the tendency towards the more utilitarian end of the market must be a concern for vehicle manufacturers and their dealers, because profitability on base models is usually low.

Some of the more community-orientated car sharing schemes embody wider societal aspirations and lifestyle choices which, if not quite anti-car, do at least embrace other modes of travel and choices that do not entail car travel. That is to say, car sharing can be complementary to attempts to 'localise' life and foster a sense of community in which the emphasis is more on quality of life rather quantity of material possessions.

Alternatively, some of the car sharing models emerging from the elite car brands seek to find new ways to express the luxury of the brand. In 2017 Bentley was reportedly investigating the

possibility of 'a global Bentley customer network' in which the idea is a membership scheme for access to multiple cars, rather than ownership of a single vehicle. The 'club' would allow members access to what the CEO describes as "a luxury mobility solution" in various cities around the world (Davies, 2017). Similarly, a scheme developed by Audi called Audi On Demand is self-defined as a 'premium service' (Lloyd, 2017). In this scheme there is a blend of courtesy car service and daily rental service, all managed and delivered from the franchised dealership. Cars are delivered to the user, fully fuelled, maintained and prepared by the dealership and can be paid for per hour or per day. As Audi claimed, the business has more than 3,000 dealerships worldwide all of which are supplied with demonstrator and courtesy cars that could be used more intensively, particularly at weekends (and for this Audi has established the Audi At Home service).

3.2.3 Re-appraisal of automobility dependence

In the longer term the impact of car sharing on the wider issue of automobility depends in part upon other developments in, for example, ride sharing and ride hailing. The initial evidence from car sharing schemes is largely positive in that in most cases there is a reduction in the number of vehicles owned by subscribers to a scheme. Car sharing seems to displace outright ownership.

Kopp and Gerike (2015) show that free-floating car sharing members were drawn from a new pool of travellers, they were not attracted by existing station-based car sharing schemes. Furthermore, when compared with those that were not members of car sharing schemes, those enrolled in free-floating car sharing showed different travel patterns. Those in free-floating schemes made more trips, but also travel patterns were more inter-modal while the share of cycling was significantly higher than car owners and the shares of private car trips were significantly lower. Integrating car sharing membership into a portfolio of travel options therefore was closely associated with different travel behaviour, though whether this is cause or effect is less certain.

Related to this point, those engaged with car sharing also appear to be more prepared to use alternatives to the car whether private (e.g. a bicycle) or in the form of public transport. In other words, car sharing does in general seem to be a mechanism to reduce automobility dependence. Much of the reduction in automobility dependence may ultimately be psychological. Individuals with a car already paid for and sitting in proximity to their residence will by default take this car as an easy option. Car sharing may force a more explicit and considered decision over whether a car is the best choice under the circumstances, and possibly over whether the travel is needed at all. It has long been recognised that the marginal cost of using a car is small for most consumers, especially when they fail to take into account the fixed costs of car ownership. Car sharing may present consumers with a more realistic view on the cost of each trip, and hence lead to more rational decisions.

On the other hand, Schmöller et al. (2015) show that car sharing users may exhibit 'surge' demand that the system is not equipped to deal with, thus leading to imbalances in supply and demand of vehicles. Surges in demand may occur due to changes in the weather for example, but also due to large public events or incidents. It is known that the ride hailing firm Uber use a surge-pricing model under these circumstances to rebalance supply and demand. With the development of software applications to manage vehicle locations and their state of readiness then it should be possible to improve the efficiency of operations and reduce costs.

Reducing automobility dependence in urban areas can be a contribution made by car sharing schemes, but it is likely to be contingent upon the robustness and availability of vehicles through those schemes, and upon the range of alternative mobility modes available.

3.2.4 Product mix, electric vehicle as an example

As noted elsewhere in this report, a feature of the car sharing fleets in the EU is that overall they tend to have a much higher proportion of electric cars, either in terms of the proportion of purchases or of the proportion of the total vehicle fleet.

The high proportion of electric cars (circa 8-10% of the total in the fleet compared with <0.1% of all cars in circulation) puts car sharing in the leading edge of technological innovation in the automotive industry and market. The car sharing applications are therefore very important in terms of acclimatising consumers to the reality of electric car use, both in terms of limits and in terms of benefits and scope.

Car sharing schemes enable a relatively low-cost and low-risk means for car users to experience electric cars, and in general that experience is likely to be positive. In this way, car sharing schemes appear to be a useful way of accelerating the uptake of electric cars with the attendant social, economic and environmental benefits for the localities in which the schemes operate. According to research from Firnkorn and Müller (2015) in a split-sample comparison of users having previously driven electric vs. gasoline car2go-cars showed that having driven an electric-car2go increased the willingness to forgo a private car purchase. Moreover, respondents were even more well-disposed to adoption of an electric car if the electricity had a 'green' generation source.

Moreover, car sharing may be suited to electric vehicles in the longer term once range anxiety becomes less of a concern. At present electric cars with limited range may be 'confined' within localities, either in reality or in the minds of consumers, and so are suited to area-limited station schemes or to round-trip station schemes.

It is revealing that Car2Go decided to withdraw Smart models from the product range offer in the US, and to replace the fleet entirely with larger Mercedes models, just when electric versions of the smaller Smart were becoming established in the EU. A spokesperson for Mercedes was quoted as saying:

> "Car2Go does operate three successful EV fleets in Europe (Amsterdam, Madrid, and Stuttgart) but they're successful because those cities have infrastructure necessary to operate EV carshare at scale…We believe that electric is the future, and when conditions evolve in North American cities we'd be glad to revisit EV carshare in the U.S. and Canada." (George, 2017)

European cities are more suited to the smaller size vehicles represented by Smart, and have a more supportive market overall. Car sharing schemes could be an important means of furthering the electric car market in the EU.

There was a car sharing service based on fuel cell vehicles, the BeeZero based in Bavaria. According to the company website, it offered zone-based car sharing from its base in Schwabing, Haidhausen, Au and Glockenbach. The scheme was launched in April, 2016 using fleet of 50 Hyundai ix35 Fuel Cell cars and supported by Linde, the German industrial gasses group. However the experiment was closed in June 2018 as it was 'not economic'. According to a statement released by Linde:

> "The large number of inquiries we received about our vehicles also confirmed that there is a great deal of interest in H2 mobility. It has also been shown that car sharing is a great way to bring this technology to many people." (Cited in Sampson, 2018).

3.3 Other social impacts on the new passenger car market

Beyond the quantitative impact of car sharing on the contemporary market for new cars, there are other considerations that might be of significance. While the number of car sharing schemes and the vehicles they contain is relatively small compared with the overall market for new cars, there are distinct aspects of mobility where the significance of car sharing could be much greater. The car sharing market is influenced by, and in turn influences, wider social attributes and characteristics.

Wider social trends cannot be entirely isolated from car sharing. Changes to the age structure of the population, to overall economic conditions and sub-conditions such as income stability, household size and composition, and other matters are all interwoven into car sharing as it emerges into contemporary life (Prieto et al., 2017). Car sharing may be adopted as an economic necessity by those unable to afford to own a car themselves; or it may adopted as a simply functional and practical choice by those who do not wish to spend more than necessary on mobility; or it may be adopted by those for whom the social and environmental benefits of car sharing are more important than individual preference.

One general issue of importance is that of 'peak car'. This is the argument that automobility in many countries has peaked and is of declining attractiveness. It could be that short-haul flying has started to displace automobility for example, a development that can hardly be interpreted as environmentally beneficial. There is some evidence to suggest that, at least for business travellers, some substitution from other modes into air travel is occurring (Kopsch, 2012). Perhaps cars are being used for more but shorter trips within urban areas, in situations where the eco-efficiency of the car is at its lowest. Alternatives to travel, such as online social networking and telework, may have substituted some driving trips, as may home delivery services from supermarkets (Lu and Peeta, 2009; Sivak and Schoettle, 2012). Sivak and Schoettle (2012) found eight countries out of 15 where the proportion of young drivers was falling (USA; Sweden; Norway; Great Britain; Canada; Japan; South Korea; and Germany), but seven where the proportion of drivers in all age groups was rising (Finland; Israel; The Netherlands; Switzerland; Spain; Latvia; and Poland). As Cohen (2012: 377) summarises with respect to emergent indicators of de-automobilisation:

> "Although these developments suggest some instability in the socio-technical system, the lock-in of key features and the paucity of practicable alternatives suggest that declarations of a pending transition are premature."

According to the European Environment Agency, car ownership in the EU-28 area increased considerably between 2000 and 2015, growing from 411 to 500 cars per 1 000 inhabitants, an average increase of 1.3 % per year (see https://www.eea.europa.eu/data-and-maps/indicators/size-of-the-vehicle-fleet/size-of-the-vehicle-fleet-8). The EEA says:

> "The growth of passenger cars per capita is also influenced by other important factors, including (a) a decreasing number of people per household, (b) an increasing number of

cars per household and (c) increases in the average travel distance, lower accessibility to and flexibility of public transport, and changes in lifestyle patterns."

In a similar vein, multi-car households have previously been identified as having potential for the electric car market, assuming the secondary car did not have such a heavy-duty cycle.

3.3.1 Customer segments

There is no uniform agreed definition of customer segments as such. Even broad terms such as 'Millennials' are difficult to substantiate empirically, and often obscure as much as they reveal. Despite these difficulties, vehicle manufacturers and others involved in the marketing of cars often work with notions of what categories or segments their prospective customers may belong to. Clearly for mass market cars there may be several such segments envisaged as supplying potential customers. Moreover, car sharing users are traditionally considered as holding an environmentally friendly attitude, but recent studies have revealed this connection is gradually replaced by the openness to new service and societal improvements (Becker et al. 2017). In addition, according to Becker et al. (2017), self-employed workers prefer station-based car sharing because of the flexibility when using a car; on the other hand, young men with higher income are more willing to use free-floating car sharing to be an alternative of public transport in a remote area.

In the case of car sharing it is notable that for urban schemes it often appears that the customer segment target is comprised of individuals with a weak attachment to car ownership and use, because the emphasis in the 'offer' from the schemes is on attracting those individuals that drive less than a critical threshold of miles / kilometres per annum. In this regard, it is possible that substantial elements of the car sharing market are serving customer segments that are relatively precarious. As the schemes get bigger and endure longer, and as wider aspects of urban design and management begin to reflect a prioritisation of car sharing over individual ownership, so this precarious nature of the market may change. For now, however, this section of the report seeks to identify some characteristics of customer segmentation that might be important to the state of the market.

3.3.2 Stage of life

Individuals go through various stages of life depending upon age and circumstance, and these may influence the propensity to adopt car sharing. Moreover, car sharing may be one of the means by which a stage of life is made possible or at least improved.

One example cited of emergent post-automobility is the reduction in the proportion of young people (say under 25 years old) with a driving licence, or owning or having access to a car (Kuhnimhof et al., 2012). This suggests car ownership is no longer important to the urban young who are less likely to embrace automobility later. In many countries a higher proportion of the population is expected to be urban in the future, which would presumably restrict car ownership and use. However, for many of the older industrial economies this is also an era of prolonged youth unemployment. Young people may emerge from education in debt, or with no income, be forced to live with their parents, and be unable to afford car ownership. Changes in youth mobility may rather reflect the more pervasive truth that the automotive industry is subject to influence from economic cycles and conditions. It is hard to interpret the slight reduction in youth engagement with the car as a rejection of automobility per se, or indeed of the cultural status afforded to mobility in general.

Car sharing can therefore be an attractive proposition to younger people living in urban areas (Prieto et al., 2017), perhaps as students or in the early years of employment, when owning a car is both expensive and an unnecessary complication. Car sharing schemes often have a minimum age requirement that might militate against some of this potential young person market, usually because of insurance concerns. It is possible that in the future on-board recording and diagnostics of driving styles and locations will allow a more precise targeting of insurance, and hence allow more people in the younger age segments to participate in car sharing services.

Car sharing is probably less attractive, or at least demands more careful consideration, for individuals with large households to support and manage. For example, most car sharing schemes use small city cars as the basis of the offer to consumers, which will not be suitable to families with several children.

3.3.3 Motivations

It is still the case that for many individuals, car ownership and use is tied up with complex personal values related to social status. In many respects the motivation for car ownership is far beyond the simply practical but includes the physical and emotional security of being cocooned in a personal space (Wells and Xenias, 2015).

For many individuals the car has come to be defined as an extension and public expression of the self, and as such tends to generate powerful emotive content (Sheller, 2004) such that it is attributed with the ability to convey and confer social meaning, reflecting divisions within society (Vanderheiden, 2006; Wells, 2006; Anderson, 2008). McCracken (1986: 71) summarises this point well:

> "Consumer goods have a significance that goes beyond their utilitarian character and commercial value. This significance rests largely in their ability to carry and communicate cultural meaning".

To many observers, the car is the core product in consumer culture. The public display of car ownership could be the ultimate expression of personal clothing and appearance. Jackson (2004: 13) in a comprehensive review of theories relevant to sustainable consumption said:

> "There are few places where the insight that material goods have symbolic value is more naked to the popular scrutiny than in the case of the automobile, which has long been recognised as far more than a means of getting from one place to another".

People can have relationships with their cars, and the character of those relationships may have an influence on many aspects of mobility including the preference for driving or the willingness to change from one vehicle to another, or to embrace car sharing.

For some individuals, identifying with car sharing can also be a positive message to others, and in this regard brand associations can continue to apply to car sharing as much to car ownership. The brand does not have to apply to the vehicle manufacturer, but may be an amalgam of the manufacturer brand and the car sharing brand (in a manner similar to HP with Intel Inside co-branding a laptop).

According to Paundra et al., (2017: 121):

> "…instrumental attributes generally impact preferences for car sharing services, and that a low psychological ownership may lead to a higher preference for a shared car under specific circumstances. This suggests that not only instrumental car attributes, but also psychological disposition, specifically psychological ownership, of potential customers need to be taken into consideration when developing measures to stimulate car sharing services in society."

3.3.4 Multi-car households

The growth in multi-car households may offer some opportunities for the car sharing market, particularly if there are constraints on the ability to park cars near the place of residence due to congestion or parking controls.

In much of the EU there has been a growth in multi-car households. There may be many reasons for this growth, including for example the relatively static inflation adjusted price of new cars and the increased participation of women in the workforce resulting in households with two income earners, and often with two distinct mobility requirements.

Care is needed in interpreting the data where it is available. For example in the UK there has been a growth in the proportion of multi-car households but some of this is explained by younger people having to remain in the parental household because they are unable to afford their own accommodation. In different circumstances these individuals would be living in their own (single car) household.

Nonetheless, multi-car households offer some opportunity for car sharing, particularly if one or more of the additional cars is not intensively used. According to a study of The Netherlands by Nijl and van Meerkerk (2017), car sharing reduced car ownership levels by 30% compared to the situation before car sharing, and distances travelled fell by 15-20%, with the shared cars replacing second or third cars in households.

3.3.5 Lifestyle

Lifestyle is a generic categorisation that lacks precision and is difficult to measure empirically. Concepts such as 'hipsters' penetrate the popular imagination and resonate because there is some underlying truth in the generalisation, even though defining the 'truth' may be difficult to achieve.

Along with lifestyle concepts come aspirations and their manifestation as action in real choices over both substantive and trivial issues ranging from desired work and living arrangements, to hairstyle, clothing and food. Inevitably, these are difficult issues to capture.

Yet it is apparent that some of the emergent lifestyle choices do not involve or prioritise cars. In urban areas where multiple transport mode choices are available it is the destination of travel rather than the journey itself that is important. These subcultures and lifestyles are not necessarily anti-consumerism. Indeed, it is often the modes of consumption in terms of cafes, restaurants, clothing, and accessories that define the visible manifestation of lifestyles of a more or less transient quality.

Again, it is hard to know how far car sharing is caught up such trends, and whether car sharing may grow or decline as various lifestyle choices come and go.

3.3.6 Trip purposes

Many car sharing schemes attempt to define certain types of trip as suitable for the scheme, or indeed the design of the scheme may allow or preclude certain sorts of trip.

It is well established that many trips are of short distance and duration, being confined to a locality. It is often the case that transport trips are defined in terms of the reason for travel in functional terms: Going shopping; going to work, etc. Of course, many trips may combine activities, for example dropping the children off at school when driving to work or picking up friends while driving to a football match.

A consideration is how far car sharing can substitute for certain types of trip purpose, and on what basis. The ability to do so may depend upon the frequency or regularity of the trip, and the extent to which alternatives are available and considered viable, including the 'friction' caused by having to learn how to use the alternatives. This means that in some urban areas a visiting tourist might find it easier to use a shared bicycle or the metro service compared with a car sharing service, for example. Alternatively, a person travelling occasionally from one city to another might usefully access a ride sharing service rather than a car sharing service.

In short, the mobility 'landscape' has never been more complicated and with more choices than now. The reasons for taking trips, and the modes by which such trips can be undertaken have increased enormously. Overall, populations are travelling more and further than ever before, and this too makes the future prospects for car sharing more unpredictable even if in general the structural shifts would appear to be beneficial to such schemes.

4 Impact on overall market and other initiatives

As noted elsewhere in this report, the impact of car sharing on the market for cars and on continued car use is determined in part by the relationship with other modes. These alternative modes and mobility schemes have increased with time, especially but not exclusively in urban areas. Alternative modes and schemes of use for those modes may be complementary to car sharing, or competitive with car sharing, or even both.

Here we can distinguish between modes of use (bicycles, trains, etc.) but also schemes of use (bicycle sharing schemes, single pass urban transport schemes, etc.). There has been steady

growth in pedestrianisation of urban centres and some sub-urban neighbourhoods, alongside attempts to sustain or improve public transport while constraining car use. The emergence of air quality toxic emissions zones in major urban centres is a feature of recent years, while since the VW scandal first emerged in 2015 it has become evident that market sentiment has somewhat turned against diesel. Hence the combination of mode choice proliferation and the emergence of certain restrictions on car use presents a context broadly supportive of car sharing, but in a dynamic and complex way.

We may expect that car sharing will ultimately contribute to a reduction in total demand for new cars, and for a shift in the product mix (for example accelerating the uptake of electric cars).

4.1 Compete/cooperate with other transport modes

In general terms the available research into car sharing and the relationship with other modes and schemes shows that car sharing is often complementary to public transport in direct and indirect ways, and competes with private car ownership and use. Put another way, car sharing members appear to reduce their ownership of cars on average, though the exact displacement rate is variable.

Car sharing schemes can provide a degree of flexibility (in terms of routes, destinations, travel times, etc.) that many public transport systems are unable to provide. This flexibility can then be used to link up with the fixed points of the public transport system in a more or less seamless manner. Hence car sharing may directly boost the usage of public transport systems. Moreover, the indirect effect of reduced congestion may be to improve the flow of some modes of public transport, thereby further increasing the attractiveness of the service. Research evidence repeatedly highlights that car sharing users reduce the total number of cars in use, with resultant benefits in terms of congestion, energy use, carbon emissions, pollution and other gains (Baptista et al., 2014).

There are differences between integrated and non-integrated car sharing schemes, and between those offering free-floating services and those that are round-trip and station based for example (Kopp and Gerike, 2015).

Local authorities at regional, urban or local level may seek to enhance the transfer between modes through the planning and location decisions around the permissions given to car sharing operators. For station-based schemes such provisions will include the site allocated for the station (as in Autolib for example). For other schemes it might entail waivers over car parking restrictions. In the case of Autolib it was important that all the local jurisdictions within the city were prepared to support the strategy and allocate stations. More generally, the available evidence suggests that car sharing schemes are at their most successful when integrated into transport policy (Dowling

and Kent, 2015), which in turn suggests a long-term and strategic outlook is need from both the car sharing providers and the urban authorities. As a simple example, Balac et al. (2017) demonstrated that increasing the cost of car parking increased the usage of free-floating car sharing schemes.

4.1.1 Integrated car sharing systems

4.1.1.1 Public transit

Integrated car sharing schemes can be understood as those which are closely aligned to the provision of public transport, sometimes directly through vertically integrated ownership. The public transport provider such as a train operator may offer car sharing services at the point of departure or arrival for travellers, and may include that service in the payment system. Usually this would include the proximate provision of car parking or stations for the car sharing service and a relatively limited travel range expectation for each sharing trip.

There are two ways to consider the relationship between car sharing practice and public transit. First, car sharing can be a good complement for public transit, because on the one hand it increases the accessibility of carless household and adds more opportunities for public transit, on the other hand it reduces the car usage of the households that already own the car in order to get access into the public transit (Martin and Shaheen, 2011). Secondly, some specific car sharing models can be potential competitors for the public transit, for instance, Le Vine et al. (2014) have found that point-to-point car sharing was more likely to be a substitute for public transit in London.

The Finnish capital city, Helsinki launched a point to point on-demand minibus service which was called Kutsuplus in 2013. The ultimate goal of Kutsuplus is to transform conventional public transit into a mobile phone-based mobility service in order to compete with the private car ownership. The price of Kutsuplus is more expensive that bus fare but cheaper than taxi with the same distance, and the payment can be made through mobile app. The pickup points were designed close to city bus stop which allowed users to walk less distance to get on the bus. As the Project Manager of Kutsuplus said (HSL, 2016):

> "Smoothness and flexibility of shared journeys as well as ease of payment and use increase demand. Demand for cost-effective transport services responsive to individual travel needs continues to increase. In future, packages may consist of much more than simply rides, such as holiday and event transport including entrance fees."

However, this innovative ride-pooling service has been closed due to the poor economic performance, although the service gained some degree of popularity among the users in Helsinki. According to some feedbacks from users, they were the only passenger in the minibus, although the purpose of this service is to share the minibus with other passengers with same direction.

4.1.1.2 Tourism

Tourism services have been traditionally dominant by service companies such as hotels, restaurants, taxi, and other transport companies. However, more and more tourists are embracing the "sharing economy" in order to gain quicker access to such services, and this trend also exerts pressure on the established industry. For example, Airbnb is considered as the biggest disrupter to the traditional hotel business model, and similarly local taxi companies can hardly compete with Uber with respect to the service quality (Longhi et al. 2016).

With respect to car sharing practices, tourists are always new to a city and without any knowledge about the local attractions. Car sharing business can thus provide an ideal alternative for tourists to explore the city at any time and locations. According to Car2go's press (Car2go, 2017), cross-border rentals have increased by 80% to 33,000 journeys in the first quarter of 2017, the number was booming due to both business travel and tourist visits in the European Car2go locations. According to Car2go CEO Olivier Reppert, said:

> "Whether for a vacation or business travel, whoever wants to be out and about in other cities welcomes the practical and simple use of the car2go car sharing service. Our customers see themselves as part of an international community who like to share a car even beyond their own country's borders."

4.1.2 Non-integrated car sharing systems

Non-integrated systems are those that are not explicitly designed with an interface with public transport in mind, although in practice users may choose to transfer from car sharing to public transport or vice versa.

4.1.3 Other implications

At a cultural level, the shift towards a range of 'access-based consumption' modes suggest a reduction in the affinity towards outright ownership towards a more 'on-demand' orientation in which the service previously provided by ownership is accessed (Bardhi and Eckhardt, 2012).

Access-based consumption is still market-based, but there is no transfer of ownership of the asset. This is distinct from simple sharing, where no financial reward is obtained and no fee is paid.

Car sharing, as with other aspects of the sharing economy, occupies a somewhat ambiguous or contradictory place in social discourse. This contradictory element is evident in the different types of car sharing scheme: Some are overtly capitalist businesses in which the focus is on efficiency and the return to investment while capturing market share; others are imbued with ethical values that transcend or even challenge the primacy accorded to market forces and offer up alternatives. This is what Richardson (2015) identifies as both constructive and deconstructive aspects of sharing. The paradox of car sharing is that it can therefore be seen as a substantive challenge to business as usual and primacy of the car, and also as a threat to that primacy.

There are several other developments that could influence the future of car sharing, particularly with respect to communications and virtual reality technologies. Then there are the developments in urban logistics, on-demand retailing, and the growing shift to the 'experiential' over the 'material' as markers of a life well spent.

4.1.3.1 Bike/E-bike sharing

In 1960s, the world's first public bike sharing scheme was introduced in Amsterdam, Netherlands. The aim of this bike sharing system is to reduce traffic congestion and air pollution in city centre, however the scheme has not been successful because some bikes were stolen or confiscated by the police. Nowadays, there are more than 400 cities around the world have the similar or plan to have bicycle share scheme. There are several benefits of bike sharing schemes, which can be concluded as follows (Fishman et al. 2013):

- Flexible mobility
- Emission reductions
- Individual financial savings
- Reduced congestion and fuel use
- Health benefits
- "Last mile" connection to public transit

Traditional bike sharing system has been proven as successful in various levels, and recently some researchers suggest that shared e-bike could be more functional than the traditional bike sharing scheme (Ji et al. 2014). A good example is the demonstration project called "Shared Electric Bike Programme" that launched from the end of 2015 to the end of 2016, the project was implemented in 16 locations across England and funded by the Department for Transport (Fig. 13).

Figure 13. Map of projects (CarplusBikeplus, 2016)

According to the final report, shared e-bike can attract new riders who have rarely or never used bike before, and e-bike is more suitable for longer trip than the conventional one. More importantly, e-bike can be a competitor to personal car, because it enables more trips can be substituted by the e-bike journey (Carplusbikeplus, 2016). Similar results can be found in Jones et al. (2016)'s study in the perceptions and experiences of e-bike owners in the Netherlands and UK, the research revealed that the well-established e-bike system have potential to substitute short car journey.

It is worth noting that the mobile app based free-floating service has been booming since 2015. Especially in China, Mobike and ofo are two of the largest bike sharing companies, and their competition has changed the urban transport landscape from many ways. At the same time, the competition between these start-ups has pushed them to Europe in search of business growth out of China's bike sharing market. For instance, Mobike and ofo are two of London's biggest dockless bike sharing service- Mobike has 4,000 bikes in seven boroughs and ofo operates 2,800 bike in five

boroughs- both of them are planning to open in more boroughs in the future, which could bring customers an alternative bike sharing service (Spero, 2018).

With respect to the impact of bike sharing schemes on car sharing business, some bike sharing companies started to realise the potential integration of car sharing to their own business, and vice versa, for car sharing business. Mobike Technology Co. has launched its own car sharing service on 19th April, 2018, the shared vehicles are purely electric and manufactured by a Chinese electric vehicle manufacturer called Xinte Electric. The new car sharing service of Mobike will be integrated with the previous Mobike App, which means that customers do not need to use another app to access this new car sharing service (Pandaily, 2018). On the other hand, Uber has acquired bike sharing company Jump Bikes in order to grow as a comprehensive urban mobility platform. It shows that bikes could be a great competitor of car sharing or ride hailing business, especially for the shorter journeys in a congested urban area.

> "Uber did see the potential of having the bikes replace some amount of car trips, instead of resisting that, they embraced it and opened up the market." (Jump's founder, Ryan Rzepecki, cited in Waters and Bradshaw, 2018)

In addition, this acquisition gives Jump Bikes an opportunity to expand its business to Europe, which is considered as bigger potential for bike sharing market. The new bike sharing service will be launched in Europe, as a part of Uber's multi-modal transport service. It is worth noting that the new bike sharing service is based on e-bikes, which shows e-bikes have great potential to be an alternative transport mode for passenger cars (Fioretti, 2018).

4.1.3.2 Urban logistics

The relevance of urban logistics to car sharing is that the growth of the on-demand economy has been in part achieved by the growth of urban delivery services for a range of products. At least some of this delivery service can substitute for trips that would otherwise have been taken by those purchasing the products. The availability of rapid order fulfilment delivery services may further provide a psychological comfort to those contemplating urban life without car ownership, and hence offer potential users to car sharing schemes.

There may be no precise agreement as to what constitutes the on-demand economy. A typical business press definition is:

> "The On-Demand Economy is defined as the economic activity created by technology companies that fulfil consumer demand via the immediate provisioning of goods and services." (Jaconi, 2014)

In essence there is usually a combination of Internet presence and physical logistics or mobility system that allows consumers of goods and services easily and quickly to identify what they want and arrange for the satisfaction of that want. The Internet platform is a key component, clearly, enabled by rapid connection speeds and the widespread penetration of computers, tablets, and smartphones. For business interests then, and in terms of the ways in which it is presented to the consumer, the on-demand economy is about making transactions faster, safer, and easier. Intermediary facilitators such as PayPal have emerged to enable transactions, alongside new Internet banking offerings from traditional financial institutions. Other sorts of intermediary (such as Amazon) may act to allow comparison shopping; but alternatively an Internet platform may enable a business to have direct contact with consumers. In general, there has been a proliferation of channels to market which has the possibility at least of allowing consumers to select the channel most appropriate to their position and requirements

There are several distinct potential advantages for consumers with respect to the on-demand economy including:

- Ability to purchase goods and services without the previous constraints over time and place;
- Ability to purchase goods and services from home, or indeed via a mobile connection;
- Greater range of choice (and price) than would be available from a physical store or cluster of stores;
- Ability to arrange delivery times (or pick up times) to suit other aspects of life, potentially also saving time in these activities;
- Often greater ability to use 'menu' pricing to pay for just the goods and services desired, and no more… including the use of premium prices for e.g. rapid delivery or popular delivery slots.

The impact of on-demand urban logistics on the overall transport system is currently unknown as it such a rapidly evolving area of activity (Dablanc et al., 2016). There are multiple possible configurations in terms of the design of delivery routes, drop-off and pick-up points and innovative delivery vehicles (see Cardenas et al., 2017; Ranieri et al., 2018). It is likely that there is a degree of 'additional' trip generation around small-quantity orders, and some substation with, for example, traditional postal services. Emergent technologies such as drones and 3D printing could influence urban logistics still further, with an overall reduction in the number and volume of logistics trips by vehicles expected (Mckinnon, 2016).

For some types of urban logistic service, such as the retail grocery deliveries of companies like Ocado in the UK, then there is a clear potential to substitute for personal trips including those by car (Boyer and Hult, 2005; Belavina et al., 2016).

5 Scope/market opportunities for the car sharing models

"We don't really see the business case with the current car sharing programs," (Audi spokesman Moritz Drechsel, cited in Behrmann, 2015)

In this section an account is given of five examples of car sharing, one from each of the business model types identified. These examples are not intended to be definitive or representative as such, neither are they necessarily best practice. In some of the cases the examples chosen are the largest of their type, and hence can be illustrative of comparative 'success' and the advantages or disadvantages that each car sharing model may have. In order to capture a flavour of the variety and scale of car sharing operations it is important to include some of the smaller examples, even though there is less secondary information available on such examples.

This section also discusses the more nebulous issue of the latent demand for car sharing, and the factors that might enable that demand to be activated or continue to be dormant. Accessing that latent demand will probably be key to the long-term success of car sharing overall, and of individual schemes. It may be that consumers decide to join more than one scheme in order to meet diverse needs; it may also be that car sharing schemes evolve new offers or consolidate through mergers and acquisitions. Given the diverse starting points of the many car sharing schemes, defining long-term success is rather elusive. For the local authority or community hosts of car sharing schemes, definitions of success beyond meeting reasonable mobility requirements will probably involve a host of other measures such as reduced traffic, reduced space given over to car parking, reduced death and injuries from vehicles, quieter streets and in general more 'liveable' cities.

5.1 Latent demand for car sharing practices

There is clearly a strong demand for the type of mobility that cars can provide, notwithstanding other measures to provide for that mobility. In transport policy terms the dilemma is to reduce the underlying demand for car mobility in general, while providing for the expansion of car sharing schemes offering car mobility. It is not clear whether there is some ideal number of cars for a locality, or number per capita, or indeed whether that number is zero.

Still, we can take the prevalence of the car in personal ownership and use as indicative of a strong demand for car mobility, and that in principle a substantial proportion of that demand could be met by car sharing. The main constraining factors are two: First, the operators of car sharing

systems need to be economically viable either in outright terms or via subsidy. Second, significant behavioural and attitudinal changes are required from large numbers of people.

Viability may be easier to achieve for the smaller car sharing operations that are highly 'embedded' in their communities, and with the support of local government authorities through e.g. stringent parking rules, dispensation for car sharing vehicles, etc. In these cases, and where the cars are held for a longer time period (say five years) it may be easier to achieve high utilisation rates and to get through the worst of the depreciation.

In the larger commercial operations there is potential for cross-subsidy from other activities in the group until sufficient scale and coverage are achieved. Of course this depends upon the willingness of shareholders to support car sharing. It must be a concern that the larger schemes do not appear to be profitable yet.

5.2 Examples of successful car sharing business models

5.2.1 Current success factors and future prospects

Achieving success for car sharing is in most cases about striking the right balance between availability of cars against utilisation rates. The compromise is the same with private car ownership and use: consumers pay for the constant availability of a car despite only using it for 5% of the time. The flexibility ownership confers is made possible by a high degree of redundancy with a particular asset - the car. In turn there are financial issues to consider for car sharing, and operational issues.

With respect to financial issues, the purchase price of the car and the eventual selling price of the car comprises the declining value of the asset, which must be covered along with the running and administration costs for the scheme to achieve financial viability. As noted elsewhere in this report, the purchase price paid need not be the official list price – depending upon the rate of discount that the operation can achieve. Equally, the eventual selling price is not entirely fixed or at least known at the time of purchase. If the car is held for three years (36 months) then there are many external and contingent factors that could influence the eventual selling price. A contemporary example is the impact of anti-diesel sentiment in the European Union, where the share of diesel cars has fallen rapidly in the period from 2016. In turn, market share decline drives down residual values for used cars, which means consumers will have to pay more for finance packages to purchase new cars (Pitas and Taylor, 2017). Moreover, the legal judgement allowing urban authorities in Germany to ban diesel cars unless they meet the Euro 6 emissions standards renders a large proportion of the existing stock of diesel cars very unattractive. So, any car sharing

operation holding diesel cars that pre-date Euro 6 compliance will face higher than expected depreciation rates.

In terms of operational issues, the balance between availability of cars against utilisation rates is the primary focus beyond the choice of vehicle brand and type. As the Autolib case suggests, achieving that balance is quite problematic. A surplus of cars means that subscribers can readily find a suitable car in proximity to their location at whatever time it is required, but at the expense of utilisation rates. Low rates of utilisation will mean the cars do not generate sufficient revenue to be viable, notwithstanding the revenue contribution of subscription fees. A deficit of cars means that subscribers may fail to find a suitable car as an on-demand service and may struggle to reserve cars at the desired time with a pre-booking service. Under these conditions subscribers may choose to abandon the service in totality or in part. There could be significant reputational damage, which in turn may undermine the recruitment of new subscribers.

Different business models of car sharing provision have different attributes in terms of advantages and disadvantages. For example, where cars must be returned to the point at which they were taken then the burdens of repositioning cars are much reduced, but the convenience to users may also be reduced. With electric cars the need to charge between uses may reduce the availability of cars, and hence reduce utilisation rates – a problem that is compounded if sufficient charging stations are not available at the right time and place.

Data from the German association for car sharing (bcs) shows that free-floating and station-based schemes are very different in business dimensions (BCS, 2018). By the end of 2017, the free-floating schemes had 215 customers per vehicle, whereas station-based schemes had only 53 per vehicle.

In brief, running a large car sharing scheme is difficult. It is arguably more challenging than traditional rental operations. Huge amounts of work are going into the development of software solutions to assist with fleet management. In addition, as users become accustomed to the specific compromises of 'their' car sharing operation then perhaps a more stable pattern will emerge that will assist in operational planning.

5.2.1.1 Autolib: free floating with pool stations

- Introduction

The Autolib electric car sharing scheme in Paris has attracted world-wide attention as a bold attempt to redefine mobility in the city. Established in 2011 with Bolloré Group, Autolib marked a significant departure from the mainstream automotive industry, though ultimately this initiative proved to be a weakness.

★ Autolib History

Autolib is run by the Bolloré Group. While traditionally outside the automotive industry, a key interest for the Group is in lithium metal polymer (LMP) battery technology for which they hold all the patents. The battery division of Bolloré Group, Batscap has two battery factories: one in Quimper in Brittany; and a second in Montreal, Quebec. Initially, Bolloré approached car manufacturers in 2002 with their LMP technology but to no avail. In 2004 the company then partnered with CeComp in Italy, who developed the car, which in turn was designed and is built by Pininfarina as a subcontractor to CeComp, using Batscap batteries.

The so-called 'Bluecar' used in the Autolib scheme has a 250km range (urban cycle), 150km on mixed cycle, four seats, and takes eight hours for a full charge (2x16amp can reduce charging time from eight to four hours). The structure is a combination of steel and aluminum, the body panels are aluminum, with some plastic panels (e.g. bumpers). The aluminium panels proved somewhat vulnerable in use in Paris, and were one reason for a higher maintenance cost than expected.

Bolloré won the Autolib tender in early 2011 with this vehicle, the Bluecar. Bolloré had established business expertise in other relevant areas, notably data management and data terminals via its subsidiary IER (for example providing automated check-in terminals at airports). For Autolib IER supply the access card, charge points, kiosks (where you can sign up), operations centre, and information management. For Autolib, IER can keep track of cars through both GPS and via the charging points.

Autolib covers 47 towns in the region of Ile de France, with Paris at the centre. By mid-2012 Autolib had 1,740 Bluecars, 500 stations and 600 staff with a target of 3,000 cars, 1,000 stations and 1,200 staff by the end of 2013. By mid-2013 there were reportedly 82,000 subscriptions sold from late 2011 onward. Users can choose from three tiers of membership, with an additional cost depending on how much they drive. Autolib' memberships can last a day (€10), a week (€15), a month (€30), or a year (€144). About 35,000 are members with a yearly subscription. Once a subscriber joins, they are able to use the cars as often as desired subject to finding an available car and payment of the in-use fee (€7 per 30 minutes for day members, €6 for week and month-long members, and €5 for annual users).

Each Autolib recharging station has 4-6 spaces, and a terminal for signing in. Some 250 sites also have charging for other EVs (one space for a car and one space for an electric 2-wheeler). The 47 municipalities pay €47,000 per station as a subsidy, but Autolib pay a fee for the parking

spaces, which will repaid this subsidy by 2014 – four years ahead of plan. Once Autolib is profitable, profit will be shared with the municipalities.

Interviews with Autolib personnel in mid-2012 revealed that the average rental was 40 minutes and 10km for Premium subscribers. Monthly subscribers tend to use the cars for longer each trip, typically about 3 hours each rental. In addition, 70 per cent of Autolib users are in the 18-34 age-group: Contrary to expectations, tourists do not as yet constitute a high proportion of Autolib users.

Total investment in the whole project so far is €1.7 billion Euros, including cars, batteries, and infrastructure: Mostly from Bolloré. However, in turn Bolloré obtained a significant European Investment Bank loan of €75 million in 2012. As a stand-alone activity there must be some considerable doubt over the viability of the Autolib project for Bolloré, at least in the short term. The number of vehicles is relatively low (only 4,000 projected); actual numbers were 2,645 in 2014, 3,309 in 2015 and 3,923 in 2016 and once into a regular replacement cycle the Autolib 'market' might constitute 300 new vehicles per annum, but replacing these vehicles are an investment cost for Bolloré. Vandalism and accidental damage to the vehicles is an ongoing cost problem. Revenues from the subscription fees and use fees will of course become the most important income stream from the project but to date no figures have been released on this matter.

The business case for Bolloré begins to look rather more plausible when the wider context is considered. In brief, Bolloré has sought looking to expand the business in several ways. Initiatives included the following:

- Private individuals offered to lease the cars at €500 per month including a charging point.
- Bolloré offered to sell the cars for €12,000 while renting the battery for €80 per month.
- Bolloré service side of its business with new markets in Lyon (Bluely) and Bordeaux (Bluecub), Indianapolis, Turin and Singapore.

- The challenges for Autolib

Since inception, Autolib has faced several technical or economic challenges. On the technical side a major concern has been the in-house battery technology which has not proven ideal for applications in cars. A key problem here is that the battery continuously discharges even when the vehicles are not in use in order to maintain operating temperatures.

Economic concerns over the quality and cost of the vehicles appeared early on in the project. It is perhaps indicative that Bollore Group sold 942 vehicles to individuals in France in the first 11 months of 2016, down 15 percent from a year earlier (Nussbaum, 2017).

However, questions have also been raised about the fundamental business model adopted in Autolib, and hence its long-term viability. In brief, in the period since inception Autolib has not

been profitable because while the number of subscribers has grown, the frequency of use of vehicles by subscribers has declined (Louvet and Jacquemain, 2017). According to press releases from Bolloré the estimated number of subscribers for the service to be profitable has changed:

- 2013: 50,000
- 2014: 60,000
- 2015: 82,000
- 2016: 150,000

As Louvet and Jacquemain (2017) show using public data on Autolib, the number of subscribers and income from those subscriptions has grown substantially year on year, but the income contribution from actual rentals of vehicles has not grown as strongly, particularly once price increases per rental are taken into account. If the growth in the number of cars is also accounted for, then revenues per car have grown very slowly compared to subscriber numbers. According to this study, from June 2014 to November 2016, the number of annual subscribers per car in service increased steadily. In December 2016, the service had 34 "1 year" subscribers per car, compared with 22 in June 2014. However, while average trip times remained the same, the number of trips per subscriber fell in proportion to the growth in the number of subscribers per car. Another way of thinking about this is that for each car the average number of trips per day has fallen… in effect utilisation rates have declined as the number of subscribers has grown.

Autolib has drawn attention to the spatial distribution of cars and stations, in part imposed by the city authorities, that has resulted in too many vehicles being left at stations where consumers do not want to pick them up. This has resulted in repositioning costs and reduced utilisation rates. About 200 such stations are a concern to Autolib, out of a total of 1,100 (Nussbaum, 2017).

In January 2017 shares in the Bolloré company Blue Solutions SA (the holding company for the battery production operation), fell by more than two thirds since peaking in mid-2014, wiping out 775 million euros ($823.5 million) of shareholder value.

- Prospects for Autolib

The Autolib car sharing service had optimal conditions in Paris, with a densely populated area of relatively affluent potential consumers, a significant urban mobility problem to solve, and strong political support from the city authorities. Autolib prices were also relatively low; even after price rises the fees in 2016 on average were that one kilometre using Autolib' cost an average of €1.13, against €2.40 for a kilometre by taxi (Louvet and Jacquemain, 2017).

Expansion into other locations has mostly been heavily subsidised, or the rate of expansion has been considerably less than anticipated (e.g. in Singapore; see Cheng, 2017)

In a manner similar to the Uber approach to market growth, the initial success of Autolib can possibly be traced to the relative confidence of vehicle availability without undue time or distance constraints. Greater understanding is needed of this psychological aspect, to understand how far and in what circumstances consumers are prepared to tolerate time or distance constraints before they start to abandon the service or dilute their usage of the service.

The French weekly newspaper Le Canard Enchaine reported that Autolib is expected to have a €179 million deficit by the end of the contract in 2023, of which two thirds will be assumed by taxpayers, since losses for Bolloré are capped at €60 million (Nussbaum, 2017).

In the future it has been accepted by Bolloré that the company cannot compete on price with the high-volume car manufacturers, and that the battery technology remains a challenge. It is likely therefore to focus more on the management system for car sharing, probably in partnership with vehicle manufacturers or city authorities.

5.2.1.2 Greenwheels: Round trip station-based

- Introduction

Greenwheels is a long-established example of a car sharing scheme based on the round-trip and station concept. It is one of the biggest examples of its kind in the EU but has struggled to expand beyond The Netherlands and Germany, and has more recently become closely aligned with VW Group.

- Greenwheels history

Greenwheels is the trade name of the car sharing group founded as Collect Car B.V. on 21 June 1995 in The Netherlands, where it retains a strong market presence. In 2004 expansion into Germany was enabled via the purchase of StattAuto, based in Hamburg. Significant structural changes occurred in 2013, probably reflecting the inability of the operation to achieve a sustainable market presence. First, Greenwheels announced in March 2013 that their operation in London, UK would cease. Although small and only operational in two London boroughs, it was nonetheless a significant symbolic moment. Second, in April 2013 a consortium consisting of the Volkswagen Financial Services AG (60%) and the Dutch VW importer Pon Holdings B.V. (40%) acquired shares in Collect Car B.V., theerby giving VW Group a significant (and probably controlling) say in the business.

Thereafter, in 2016, Quicar in Hannover was acquired by Volkswagen Leasing GmbH. Greenwheels then took over the operations of some 60 existing Quicar stations and 80 vehicles in a move that is mostly concerned with achieving economies of scale and is probably indicative of

future restructuring in the EU car sharing market. Quicar had previously been created by VW Group.

According to Bosteels (2016) Quicar started in 2011, with some 200 cars and about 70 stations across the city. By 2016, only 120 cars were left, used by some 12,500 registered users. These numbers were deemed too low to be viable, hence the transfer to Greenwheels. At the time Greenwheels had about 1,700 cars in the Netherlands. The presence in Germany was modest, with perhaps 150 cars across 22 cities.

- Greenwheels current situation and future prospects

Further to the relationship with VW Group, Greenwheels is replacing the fleet of mostly Peugeot 207, 107 and electric iOn models with those from VW, principally the Up! The Greenwheels system is not particularly suited to short-term (tourist type) usage because it requires a membership processing procedure that takes a few days before the (new) member gets a chip card. Applicants must be over 24 and have a bank account in Netherlands or Germany, and pay an initial deposit. Thereafter there is a flat subscription fee of either €5, €15 or €25 per month. The tariffs are based on whether the subscriber is an occasional, regular or frequent user. Then there is a combined time and distance charge. The per hour rental charge is €3.10-€6.10 per hour during the day and €1 per hour at night 00:00-08:00 while the distance charge is €0.12-€0.21 per kilometre driven. If you need to fill the tank (which should be done if less than a quarter full) then fuel is paid for by Greenwheels using a special bank PIN card. Various packages are offered (day, weekend, week). The scheme is thus best for those with relatively occasional requirements for a vehicle, or for those who can plan their vehicle needs in advance. It has the advantage of national coverage and the bundling of all other costs (fuel, insurance, maintenance), so simplifying matters for the consumers. Greenwheels claims that for those driving less than 15,000km per annum, their offer is cheaper.

Greenwheels has been operational for twenty years, yet total fleet numbers are small. The claim is that 21 customers use one car, but there is no verification of key data such as utilisation rates, revenues per subscriber, etc. While branding in the two key markets is well-established, with for example links to the railway network, the prospects for growth seem distinctly limited as the business concept seems premised on meeting the needs of those for whom outright car ownership, or outright dependence upon public transport, are not viable options. Being a station-based and round-trip scheme further limits the appeal of Greenwheels (though cars can be rented overnight and parked at residential addresses), although it may help to contain costs.

5.2.1.3 Drivy: Peer to peer (Roundtrip homezone-based)

- Introduction

Drivy is an example of a peer-to-peer (P2P) car sharing system in which the organisation acts as an intermediary between those that want to allow their cars to be used by others, and those that want to access a car. As with other intermediary operations such as AirBnB, Drivy generates revenues by charging a management fee when brokering the relationship. The business model is very different from traditional approaches, because Drivy does not own the assets (the cars). Rather, their competence is in terms of the system that connects drivers with car owners.

★ Drivy history

Drivy was founded in France in 2010 and followed an incremental country-by-country expansion strategy thereafter. Hence the next market was Germany in 2014, followed by Spain in 2015. Thereafter Drivy offered services in Austria and Belgium in 2016 after raising €31m on financial markets, and thereafter in late 2017 in the UK (with a focus on London).

A key step in the establishment of the Drivy scheme was the provision of insurance. According to the founder Paulin Dementhon it took 12 months to gain an agreement from an insurance company to underwrite the P2P car sharing model (Val, 2017). In 2014 Drivy switched to a long-term partnership with Allianz. According to reports[4] from Allianz UK Jonathan Dye, head of motor insurance, Allianz Insurance, said:

> "Innovative insurance solutions are needed to support the growth of the sharing economy and tailoring insurance cover is one way we can do this. Attitudes to mobility are rapidly changing and it's important that Allianz provides customers with options whether they own or rent vehicles."

Paulin Dementhon, CEO, Drivy added:

> "Working with Allianz, allows us to cement trust with our users as we roll out our car sharing service across the UK. Insurance is a key consideration for everyone - whether they are a car owner or driver on the road. So through Allianz we can ensure everyone is safely protected, however a car fits into today's lifestyles."

[4] https://www.allianzebroker.co.uk/news-and-insight/news/allianz-partners-with-drivy-to-provide-insurance-for-car-sharing-platform.html

Following on from the decision to expand into the UK, Drivy took over the business of DriveLink, at the time the biggest P2P operator in the UK. DriveLink had been founded in 2015 but had decided to exit the market and essentially transferred all the car owners and those wanting to rent cars over to Drivy (including customers in Spain and Germany). This strategy of expansion through acquisition is evident elsewhere. In 2015, Drivy acquired Buzzcar, Livop (French competitors) and Autonetzer, a German competitor. According to a press release from Drivy, DriveLink could not afford the investment needed to expand the business.

As of late 2017, Drivy claimed to be operating in France, Germany, UK, Spain, Austria and Belgium with a total of 50,000 cars to rent and 1,500,000 users while employing just 100 people in Paris, Berlin, Barcelona and London, while membership was growing at 120 cars per day.

- Drivy current situation and future prospects

Drivy has an interesting strategy in terms of opening up new markets. Typically, Drivy offers a minimum monthly income for listing a car, even if nobody rents it. After a while, Drivy then looks to remove this bonus when there are enough clients. In the case of the UK this bonus consisted of £250 as a minimum monthly income.

As of early 2018 Drivy claimed to enable more than 3 million days of rental for a community of 1.8 million users, and more than 50,000 cars on the books. Key to this has been continued development of the business proposition in terms of the nature of agreements entered into, insurance, and vehicle recovery services. According to Drivy the average daily fee is €29 per day. Of this, the car owner obtains 70%, the insurance company 13% and Drivy 17%. In addition, Drivy has partnerships with roadside recovery organisations on a national or international basis. In 2018 Drivy announced a global partnership with ARC Europe Group for roadside recovery (Guinet, 2018).

Drivy is frequently adjusting the nature of the market offer and the ways in which it works with car providers and users. This includes:

- Expansion into corporate car providers
- Offering shorter-duration rentals
- Changing the terms of insurance conditions
- Developing the app to make a seamless process include access to the vehicle (DrivyOpen)

In 2017 Drivy introduced changes to its insurance coverage, such as reduced deductibles and full deductibles. In the beginning, Drivy offered only one deductible of €800. Over time, it realized that the deductible was costly compared to the price of the rentals and their users' budget, so it introduced a reduced deductible option of €150.

The essence of the Drivy approach is to reduce 'friction' in the entire process, thereby making it easier to provide and to rent the cars. For example, electronic signatures can be used to start and end rental periods.

The corporate expansion strategy seems well-grounded, and the business is continuing to grow quickly. In turn, rapid growth will generate a customer base large enough to offset running costs in software and administration. Thus far the take up, while impressive, is still a niche market. There clearly are car owners willing to provide cars in return for revenue, and hence to work their domestic assets harder.

Alternatively, the Drivy proposition does not make a great deal of difference to the overall market in the sense that the cars have already been bought and are in use, it is just that the intensity of use (the utilisation rate) increases. There is no evidence yet regarding whether those renting the cars have deferred car purchase decisions or have sold cars on the basis of being able to rent when needed. The greater the intensity of use, the faster vehicles may 'age' and hence be retired… but again at present this is a minor consideration. If vehicle owners find the additional income is sufficient to enable them to retain their car, schemes like Drivy may actually help sustain the current car population rather than reduce it.

5.2.2 Scope for future success

A majority of protagonists consider that there is substantial scope for further expansion of car sharing, building on existing growth rates. It is worth noting, however, that while car sharing has a relatively long history in a variety of formats, the 'headlines' are being captured nowadays mostly by rather different concepts. The two most important areas are peer-to-peer ride sharing as in the Bla Bla Car model, and ride hailing as in the Uber model. While very different in operation and character both of these new additions to the automobility 'landscape' offer potential competition with car sharing schemes. Interestingly, in ride sharing and ride hailing the 'user' does not need a driving licence and therefore these concepts potentially are able to reach a larger market than car sharing.

In addition, peer-to-peer car sharing as in the Drivy model represents a rapidly growing version of automobility, albeit one that does not as strongly generate wider social and environmental benefits.

In addition, there has been some blurring of the distinctions between types of car sharing scheme, and between car sharing and other mobility offers such as daily rental, pool cars, and outright company cars. One likely future development is therefore the emergence of portfolio

packages with regards to automobility in which different payment and use concepts are offered. Such packages are likely to appeal to corporate markets (including local governments and agencies) that wish to outsource the management of their mobility needs.

The greatest scope for expansion is likely to be in those cases where car sharing is part of a comprehensive transport planning solution. It is evident that the larger commercial schemes such as DriveNow have sought to establish in major urban locations for example. In these locations there is provision of public transport in a variety of formats, alongside multiple other transport mode choices and often high costs associated with car ownership (such as expensive parking facilities). Hence joining one or more car sharing scheme becomes a less risky choice with a 'safety net' of alternatives available.

In the really large cities such as London the scale and complexity of the urban area, including the political and administrative arrangements, can conspire to make the establishment of car sharing operations more difficult.

It is possible that while such solutions are complicated to establish in the very large cities, in the smaller and medium-sized urban areas that are typical of much of Europe there is considerable scope for reducing the number of cars under private ownership and replacing them with a substantially smaller number of shared cars. Under these circumstances it should be more possible to garner collective political approval because a majority of residents will be beneficiaries from quality of life improvements.

One possible benchmark of potential is for other markets in the EU to replicate the experience of Germany. According to the bcs, by the start of 2018 there were more than 2 million subscribers to car sharing schemes in Germany. Car sharing is offered in 677 cities and municipalities in Germany - 80 more than in 2017.

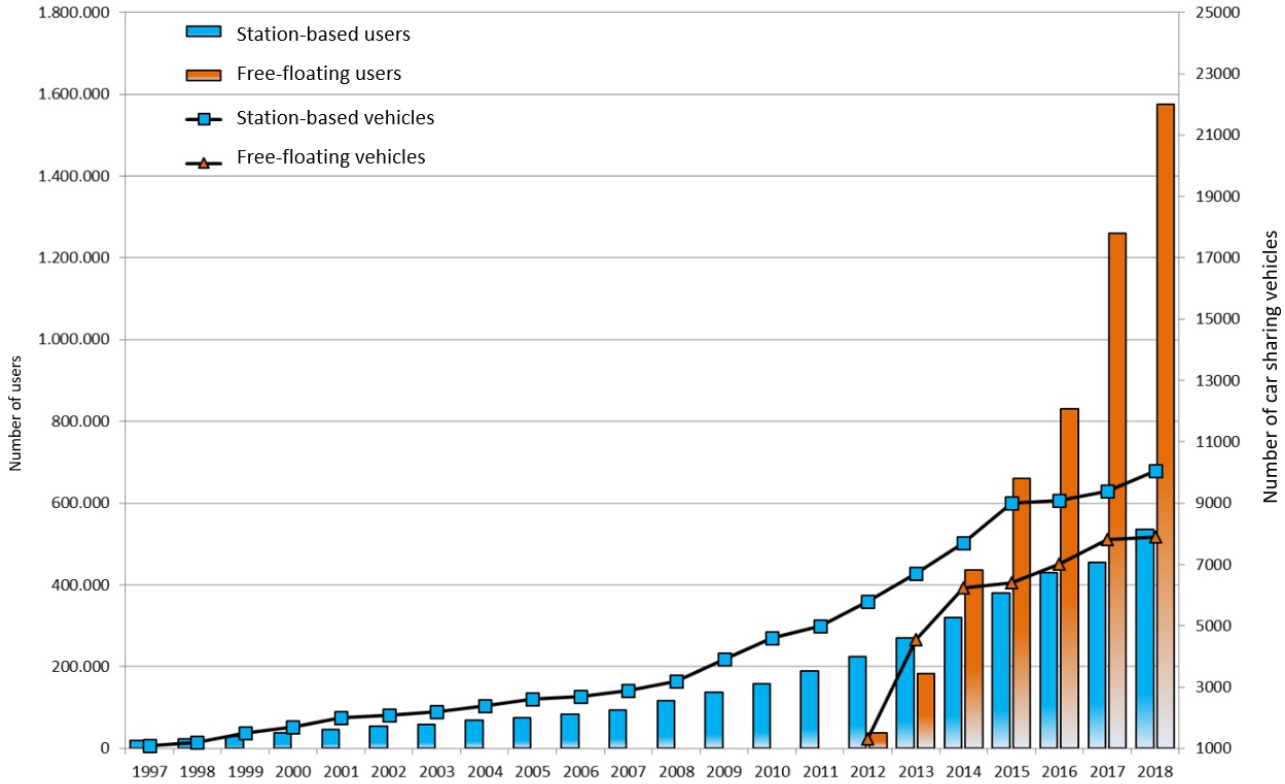


Figure 14. Car sharing in Germany, 1997 to 2018. (Source: Federal German Car Sharing Association (bcs), https://www.carsharing.de/zahl-carsharing-kunden-ueberspringt-2-millionen-market)

The station-based schemes gained 80,000 new customers over 2017, to reach 535,000 customers by the start of 2018 (up 18% on 2016). Station-based schemes had a total of 10,050 vehicles at 5,000 stations throughout Germany at the start of 2018.

The free-floating scheme providers as of end 2017 had 1,575,000 customers, 315,000 more than at the beginning of 2017 (up 25% on 2016). Free-floating schemes provided 7,900 vehicles by the end of 2017 - especially in large urban centres. The two large free-floating providers operate in seven major cities.

All the evidence from Germany therefore shows that under the right conditions a much larger EU car sharing presence is possible. It is worth noting however that Germany has about 45 million cars registered, and that the overall rate of private car ownership has grown from 400 per 1,000 people in 1993 to 520 per 1,000 in 2015 (Kuhnimhof, 2017). Moreover, many individuals may join more than one car sharing scheme, and the data do not show usage rates. It is interesting to note that Kuhnimhof (2017) argues that car sharing within households has decreased substantially over the last twenty years in Germany. This 'informal' mode of car sharing may to some extent have been replaced by the more formal schemes.

The average rate of car ownership in the EU28 in 2015 was 500 per 1,000 people, somewhat below the situation in Germany. Still, this means about 300 million cars in use across the EU. If the

rest of the EU had car sharing scheme membership at German levels it would mean about 12 million members, substantially more than at present.

Given that growth in Germany is still very strong, albeit from a low base, the potential size of the market is considerably more than 12 million members across the EU. As experience grows with car sharing so both the providers and the users will have a better understanding of the market and how best to optimise the functioning of that market. What is less clear is whether Germany represents an example that the rest of the EU could follow, or is in practical terms unique and hence unlikely to be replicated.

5.2.3 Merger and acquisition

At present there is a large number of car sharing schemes in operation, but many are small in scale having few cars and limited areas of coverage. As is discussed in the individual cases for each business model type, there has been some evidence of merger and acquisition activity of which the most notable is the merger of DriveNow with Car2Go.

Growth in the underlying number of schemes, along with memberships and cars in the schemes, is likely to carry on. At the same time, there are benefits from consolidation. Not only does consolidation result in scale economies, it also is a mechanism whereby the more efficient and competent car sharing schemes come to dominate in the market.

Scale economies arise from back-office efficiencies, purchasing economies, branding, and the ability a more comprehensive service to users. At present, even the largest car sharing schemes are an order of magnitude smaller than typical daily rental firms, and this must make competition more difficult. Car sharing schemes are even smaller when set against initiatives such as Uber and Bla Bla Car.

An interesting question is where this leaves the more community-orientated schemes. It is possible, for example, that very local schemes co-exist alongside those schemes that enable long-range (and even international) travel. In such a situation, individuals may remain in more than one scheme, depending upon the extent to which each is able to meet mobility needs. Smaller station-based schemes tend to have fewer users per car, probably reflecting a higher usage rate per user and perhaps, by extension, a greater level of embeddedness in the socio-economic fabric of the communities they serve.

5.2.3.1 DriveNow/Car2Go case study: free floating with operational area scheme

- ★ Introduction

In March 2018 it was officially announced that the BMW car sharing service Drive Now would be merged with the Daimler service Car2Go. This development had been expected following the decision by the respective services to buy-out the shares held by Sixt and Europcar respectively. In the process of creating this merged business some details were released regarding the operations of the two car sharing services which are useful to the report here.

★ DriveNow History

DriveNow was created in 2011 as a 50/50 joint venture between BMW and Sixt, the car rental company with long experience of working with BMW (DriveNow, 2017). The inclusion of Sixt was important to the establishment of the business, as the rental company had considerable knowledge, assets and experience in managing large rental fleets which BMW lacked. The original concept was for one-way car sharing, with minute-based rates. Fuel costs, parking, insurance and car tax are all included. Savings and Hourly Packages allow a further reduction of rates per minute in several countries. Only BMW and MINI models were included in the car sharing operation. As of October 2017, the operations in the EU are as in Table 7.

Cities and date of launch	Number of vehicles	Share of electric vehicles	Business area
Munich June 9, 2011	750	85	ca. 88 km2
Berlin Sept. 29, 2011	1400	140	ca. 167 km2
Dusseldorf and Cologne January 25, 2011	620	45	152 km2
Hamburg November 4, 2013	600	150	ca. 90 km2
Vienna October 17, 2014	500	20	ca. 101 km2
London December 4, 2014	310	50	ca. 84 km2
Copenhagen September 3, 2015	400	400	ca. 89 km2
Stockholm October 20, 2015	310	30	ca. 50 km2
Brussels July 6, 2016	320	10	ca. 60 km2
Milan October 19, 2016	500	20	ca. 126 km2
Helsinki May 24, 2017	150	10	ca. 40 km2
Lisbon September 12, 2017	210	10	ca. 48 km²
Total	6,070	970	

Table 6. DriveNow operations in the EU

It is interesting to note that almost 16% of the total vehicles available through DriveNow as of October 2017 were electric, and 100% of the fleet in Copenhagen. Curiously, the 2016 BMW Annual Report claimed that 20% of the European fleet in DriveNow consisted of electric i3 models. It is also notable that a relatively cautious and incremental growth strategy was followed from inception in 2011, with the major German cities and European capitals as targets. Just over half the total fleet was in Germany. BMW claimed more than one million registered customers and that one DriveNow vehicle replaces at least three private cars. In 2015 DriveNow claimed that 38% of their clients had sold their cars. It is also notable that it was claimed this did not detract from BMW sales of new cars. According to reports the BMW Chief Executive of DriveNow, Sebastian Hofelich, said:

> 'As a rule the DriveNow car did not replace a BMW. The typical BMW driver is aged 50 or older, while our customers have an average age of 32.' (Reuters, 2015)

DriveNow also has synergies with related packages including Park Now and ChargeNow. The 'ReachNow' car sharing service in North America does not appear to have been included in the relationship with Daimler.

★ Car2Go History

Car2go Europe GmbH was created as a joint venture in 2012 (although the precursor business was established in 2008), in which 75% was owned by Daimler and 25% by Europcar. On 1st March 2018 Daimler bought out the 25% holding from Europcar as a precursor to the merger with DriveNow.

As with DriveNow, the expertise offered by the car rental company was instrumental in allowing the car sharing service to become established. In making the announcement regarding the purchase of the Europcar share of the business, Jörg Lamparter, Head of Mobility Services at Daimler was quoted as saying:

> 'Over the course of the last several months, we have intensified our investments in mobility services in order to create a holistic mobility system with a broad portfolio. As part of this strategy, we decided to fully acquire the remaining shares in car2go Europe.' (autovistagroup, 2018)

For 2017, Car2Go claimed there had been 24 million rentals of its cars. Moreover, while DriveNow operated exclusively in the EU, Car2Go had operations in the EU, North America and China, and claimed 2.97 million users worldwide as of January 2018. Car2Go as of January 2018 had 26 locations (14 in Europe, including seven in Germany, 11 in North America, and 1 in Asia in Chongqing/China). Transnational usage is possible within Europe and North America. Purely electrical fleets with a total of 1,400 vehicles are available in three locations (Stuttgart, Amsterdam and Madrid). Hence about 10% of the total fleet is electric, but these are concentrated in a few locations.

In the January 2018 press release Car2Go provided more operational details (Car2Go, 2018). The group claimed at 30% year-on-year growth in the number of customers in 2017. In terms of the main urban locations the largest customer bases were claimed for e Chongqing in China (234,000 customers), Berlin (219,000 customers) and Madrid (190,000 customers). In an interesting detail it was said that during the financial year 2017, the utilization rate of the around 14,000 vehicles increased to approximately 38 percent.

★ The combined DriveNow and Car2Go group

Despite the greater geographical spread and larger number of users and vehicles, the price at which Daimler bought out Europcar was reported as €70 million, thus valuing the business at €280 million. In contrast, BMW paid €209 million for the 50% as of January share of DriveNow, thus valuing the group at €418 million. Daimler and BMW will both hold 50% of the merged business, but to date no details of the branding of the car sharing operation have been released.

It is worth noting that in a press interview BMW board member Peter Schwarzenbauer said the venture won't be profitable immediately. According to reports by Bloomberg (Sachgau et al., 2018) he is quoted as saying:

> 'We put this together to really grow now, to scale it. The first objective is to become a big player, then it can be profitable.'

This means that the largest car sharing operation in the EU is not currently profitable. It also means that there is a perception that to be profitable it is necessary to capture economies of scale in infrastructure, software and back-office functions - assuming it is possible to get the pricing structures and utilisation rates right. In 2016 it was reported that DriveNow was profitable (Guilford, 2016). According to Ian Robertson, BMW Board Member:

'The program is profitable, and the market is developing well. The utilization is two, three, four hours a day -- so that's about four times what the average is.'

It is difficult to reconcile these statements regarding DriveNow profitability with those relating to the merged entity of DriveNow and Car2Go. The answer may partly lie in the tension between the need to improve utilisation rates, and the need to have sufficient vehicle availability to meet customer expectations at all times.

5.2.4 New entrants or departures

Given that data on car sharing operations is rather fragmented across the EU, it is difficult to be precise about the rate at which new participants are entering the activity or existing participants are leaving.

5.2.5 Geographical issues

It is evident that car sharing, as with other innovations in mobility, has flourished in some locations and not in others. There are many factors that could underpin this diversity of performance, from the sheer size and physical structure of cities and towns through to local cultural disposition. An important factor in general in reducing car dependency through multiple means appears to be an enduring policy stance enforced over many years.

It is also worth noting that the passage of time can make a difference as to whether an initiative or scheme is deemed a success. The hopes that were held for the Autolib at the initiation of the car sharing scheme in Paris have not been realised. Clearly, large-scale and very 'public' failures like this are damaging to the overall reputation of car sharing schemes and in particular the ability of such schemes to make a difference to key urban themes such as congestion.

Furthermore, while there are claims made as to the degree to which car sharing displaces car ownership, there is rather less evidence with regards to displacement of car trips. In so far as car sharing actually makes such trips easier for individuals there may be an extent to which trips are either not really displaced or, worse, further trips are encouraged. Car sharing has no particular dimension of ride sharing, so there is no reason to suppose that multiple occupancy is the norm. If car sharing replicates conventional occupancy rates, then the contribution to reducing congestion and other traffic problems is of course less than it could be. There is therefore a degree of ambivalence over the contribution of car sharing with regard to urban transport issues, which may

partly explain why bicycle and electric bicycle schemes have garnered much more support from both commercial enterprises and public authorities in recent years.

The lack of progress of the larger 'professional' schemes must also be a concern. The quest for viability has seen a variety of business models adopted, but the right formula appears elusive. In contrast, the smaller and more community-orientated schemes, integrated into a wider vision of the future of urban mobility for a locality, do appear to have greater endurance. The peer-to-peer schemes are a different proposition, in that all things being equal they probably result in more people driving than would otherwise be the case or, put another way, they result in the car being used more intensively. Schemes like Drivy enable car owners to derive some income from their cars and may therefore underwrite continued ownership or the use of larger vehicles than would otherwise be the case (Higgins, 2017). Such schemes, while popular, thus do little to resolve wider transport and mobility problems in urban areas.

5.2.5.1 Local traffic rules

As noted elsewhere in this report, urban authorities are increasingly interested in the introduction of various traffic constraints and rules that perhaps mark the turning point in giving over the city to the car. There is in this sense more regulatory force behind the idea of 'reclaiming the streets' and the creation of 'liveable cities'.

Many of these local traffic rules are concerned with vehicle emissions rather than the quantity of vehicles on the roads. Furthermore, little has been done so far to address the scourge of on-street parking and the 'litter' of roadside cars that make parking a fiercely contested issue.

Still, the introduction of zero emissions zones, perhaps coupled with local parking restrictions, could in combination constitute a useful contextual framing for the growth in car sharing schemes based on electric vehicles. Pricing structures could be designed to reflect and encourage higher occupancy rates in the way that 'HOV' lanes in the US are used (High Occupancy Vehicles).

5.2.5.2 Parking

Parking is crucial to the success of car sharing, whether the scheme is free-floating or station-based. As with private car ownership, users want the cars to be as proximate as possible. Ease of access is an important consideration in the overall utility of a car sharing scheme. Again, parking must therefore be closely integrated into transport planning more generally. The problems experienced by Bollore in seeking to establish a presence in London, and gain the agreement of all the local authorities within the city, are indicative of the concerns over parking and now difficult they may be to resolve.

Station-based schemes obviously require a space given over to the parking of vehicles. If there are multiple stations, then the size and distribution of parking availability is crucial to the smooth operation of the scheme. Hence for station-based schemes there is a fundamental question of capacity utilisation in terms of parking, which is exacerbated when there are electric vehicles in the scheme that need charging over a period of time. Insufficient capacity can result in users not being able to park at the station desired (a problem encountered in Autolib for example). Over capacity provides for a better user experience, but at higher overhead cost.

5.2.5.3 Urban structure

Many European cities are relatively small in global terms, both in population and in spatial extent. They are also often old, with city centres characterised by narrow streets and pedestrianised open squares. With residential use still popular in city centres there is an in-built demand constraint for car-based mobility. As the ownership of cars has increased, so the pressure for parking space in particular is exacerbated in many European towns and cities. An example is that of Bremen, Germany (in a study to be released in the CIVITAS 2018 conference). Here the use of car sharing has been explicitly deployed as a strategy to reduce the total number of vehicles in the urban area, thereby creating more road space while reducing the need to park vehicles in private ownership. As a typical mid-size European city Bremen therefore is an exemplar of what can be achieved. The study found that:

> "…79 % of Bremen car sharing users do not have a car in their household, whereas about 80% of the reference group has a car available at the household. The mileage travelled by car of car sharers is about 25% lower than that of car owners. A substantial portion of the mileage of previous car owners who became car sharers was shifted mainly to public transport (including rail) and cycling. Car-sharers in Bremen are intense users of bicycles and of public transport. Whereas in the reference group 56% use a car to get to work, among car sharers it is only 24%. Public transport is used by 9% in the reference group but by 21% of the car sharers. The bicycle is used for commuting to work by 19% of the reference group as compared to 42% of Bremen car sharers. The survey also shows that station-based car sharing is a supplement to public transport in Bremen – car sharing users have more season tickets (78%) than the reference group (58%)."

The important elements of this study in Bremen are therefore that car sharing has become important first in reducing car dependency and second in shifting mobility use to more sustainable

options. Of course, there is a question over the self-selecting character of the car sharing cohort, who may be more disposed to use bicycles and public transport in any case. However, the results are very encouraging for advocates of car sharing in such contexts. It is interesting that the Bremen study also found an increased propensity for local shopping by car sharing households, thereby bringing economic benefits to localities that embrace the concept. Results such as this are important in deflecting concerns often raised (as in the past over pedestrianisation schemes) that retail outlets will suffer if car sharing is introduced.

In the larger urban areas such as London, Barcelona and Paris the context is different. The sheer scale of these cities, the complexity of the mobility patterns, the wide range of mobility choices, the presence of many tourists and visitors, and related contextual factors pose substantial challenges for the transport planning and management of the entire urban area.

Urban structures may influence the viability of cars and other transport options, and the demand for mobility generally. With respect to new urban developments, there may be opportunities for the design of housing and other schemes with reductions in car use in mind. Housing schemes that do not allow parking for private cars within the area, and then provide car sharing services on the periphery, have the advantage of creating safe urban spaces.

5.2.5.4 Alternative mobility provision

In many urban environments there are multiple possibilities in terms of travel options. In some cities such as Berlin those choices can all be displayed via a mobile phone app to allow users to evaluate their preferred cost / time / convenience options. In such settings car sharing is but one of several possible choices. What is less certain is whether the range of choices acts to increase the net amount of travel undertaken (by making all journeys easier to plan and execute) or is essentially a contribution to increased efficiency of travel. Equally, it is not clear how far car sharing as one option among many acts to augment the total of journeys undertaken or is an option that 'competes' with alternative mobility offers. More important from a transport planning perspective is the question of which modes are substitutes for each other, and which are complementary.

In so far as cars are removed from the roads as a consequence of car sharing, then public transport in general is a beneficiary. The implication is that more journeys will be taken by public transport whatever the mode of provision. Where car sharing schemes integrate with public transport hubs then again those hubs may benefit from increased usage. It cannot be ignored, however, that car sharing has the potential to deprive public transport of potential passengers and hence may act to undermine the viability of public transport services. In a somewhat different setting it is the case that some public transport provision in North America (in suburban settings)

has been displaced by ride hailing services for example. The positioning of car sharing as an on-demand service may readily be at the expense of other modes including mass transit (Bliss, 2018).

It is also notable that on-demand car use via ride hailing or ride sharing may result in extra trips or trips of greater length. With ride hailing services the vehicles can be in motion but lacking a passenger for a significant amount of time, even if the trip to pick up a specific fare is not counted.

While not a formal part of the brief for this H2020 project on car sharing, the rapid growth of bicycle and electric bicycle (e-bike) sharing is an emergent feature of the urban mobility environment that deserves particular consideration. Bike sharing is hardly a panacea, as the situation with the Paris Velib scheme clearly illustrates. Private sector initiatives on bike sharing have sometimes met with resistance from residents, especially where dockless schemes result in bicycles being left inappropriately. Despite these concerns bicycle and e-bike schemes are a growing feature. The bike sharing schemes are especially fast-growing in China, where the number of registered users is doubling every year and with millions of bikes already deployed in major cities by the biggest operators (Ofo and Mobike). For much 'micromobility' the use of bicycles or e-bikes is ideal, being faster and cheaper than any alternatives.

For much of Europe e-bike and bicycle sharing schemes offer an attractive blend of faster travel and related health benefits, with significant reductions in the long-term health costs to society (Fratila, 2018). The view from bicycle enthusiasts is very clear:

> "High quality, good coverage and a seamless integration of public transportation modes, together with measures that discourage people from owning and driving cars will solve almost all traffic problems in cities. In doing so, space is freed that can be used for promenades, playgrounds, terrace bars, local businesses, flea markets, outdoor event venues, parks or other green pockets, and bike lanes. Yes, lots of – preferably protected – bike lanes. Because not even great public transportation can beat the autonomy and flexibility that cycling provides, nor the health benefits or the social inclusion. Not to mention all the hard data about how cycling improves general traffic safety, air pollution, or economy." (Fratila, 2018)

It is likely therefore that some element of the market served by car sharing could be squeezed out by bicycle and e-bike sharing. Ultimately there may be a more efficient balance arrived at, with bicycles and e-bikes used for single-person trips without heavy loads, and shared cars used for multiple occupant trips and heavier loads.

5.2.6 Market opportunities and strategies for car sharing expansion

It is likely that significant market expansion is best achieved via integration with wider urban transport planning strategies rather than acting in isolation. Certainly, for those schemes that want to offer inter-urban mobility as well as serve local travel needs there is a need to fit into such transport strategies.

A key feature of contemporary urban mobility is diversity of choice. With many choices, citizens will be less dependent upon traditional car ownership and use to meet their mobility needs. There is certainly scope for car sharing within this overall process of reduced dependency on car ownership and use. Where the car sharing fleets are electric there will even greater synergies with attempts at creating more liveable cities. In broad terms, the market opportunities continue to be positive because of the increased financial cost of personal car ownership, the regulatory controls on car ownership and use, and the environmental burdens associated with traffic congestion. Personal and household ownership of cars remains at historically high levels. Some of this private ownership can be replaced by shared ownership. The attractiveness of car sharing for individuals or households can be understood in four ways:

- Economic benefits
- Environmental benefits
- Social benefits
- Lifestyle benefits

For many citizens the choice of car sharing is an economic one. But for many others there is a wider set of social values that are important considerations. In economic terms there are many situations where the net cost of car ownership is far greater than that associated with car sharing. Where annual distances travelled are low, then car sharing becomes even more attractive. It is recognised that at present many cars are owned on the basis of the (rare) moments of full use of the capability of that car. This over-specification results in a high degree of redundancy in the vehicle, which ultimately must be paid for. Unfortunately, car ownership is not reducible to rational economic decisions.

Car sharing also may appeal to those who wish to live more sustainably. It is evident that shared use of a resource results in lower environmental burdens than sole use, notwithstanding the impact of a greater intensity of use.

Car sharing schemes may appeal to those who aspire to a stronger sense of community, of locality, and of shared experiences generally. Car sharing is thus part of a wider pattern of constructing communities and supporting those communities. Such efforts are not the sole

preserve of urban areas either: smaller towns and villages may be able to enhance community solidarity through car sharing schemes.

Finally, from a lifestyle perspective the use of car sharing may appeal as part of a 'modernist' view of life. Car sharing removes the 'hassle' of ownership. Car sharing relieves the user of the need to worry about things like servicing and repair, and of the time these activities may take.

An interesting possibility for many types of scheme is the replication of success in one location by taking the scheme to another location. Local viability may confer or indicate that the management challenges of car sharing have been met and are potentially transferrable. Replication could be achieved via acquisition in some cases. This sort of incremental expansion offers some important advantages. The capital demands are relatively low, so the financial risk is low. It is possible to expand the management of car sharing schemes in line with the physical expansion of the service. Software developed for one application may be transferred to another, as may many of the tacit skills needed to manage car sharing fleets.

Such replication could apply to the big commercial schemes, the schemes that are centred on franchised dealership networks, of indeed schemes that a much more local and small scale. Alternatively, the sharing of best practice from one scheme to another can help the emergence of new schemes. New entrant efforts can thereby access the learning achieved by previous entrants. On issues such as how to charge for membership and use, and how to reach potential new users, there is much experimentation still going on.

Of course, continued growth within a locality is also an important route to market expansion. Car sharing schemes can increase membership and the number and type of vehicles on offer. As is noted elsewhere in this report, matching capacity utilisation against user expectations on car accessibility is difficult, but as car sharing becomes more embedded as one component of a suite of mobility choices so it should be possible to manage those expectations more precisely.

6 Conclusions

At present the scale of car sharing in the EU is too small to make a substantial difference to the market for new cars. Fleet sizes are generally small, and growing slowly, so the growth plus replacement demand for car sharing vehicles set against overall new car sales is small. Car sharing sales represent significantly less than 1% of the market overall.

In terms of electric vehicles, the situation is a bit different. Car sharing fleets on average have a much higher proportion of electric vehicles than the market overall, and thus they purchase higher proportion of the total electric car market – albeit still less than 1% of the total of electric cars. The benefit of the 'early adopter' status of car sharing fleets in terms of the use of electric cars is that these initial purchases accelerate the learning curve and economies of scale for vehicle manufacturers, which in turn leads to the faster adoption of electric car technologies in the market overall.

The supply of cars to car sharing fleets is dominated by the vehicle manufacturers and the daily rental industry, and fits into a broader pattern whereby distinct routes to market enjoy distinct levels of discount and length of ownership.

At present the provision of car sharing fleets does not appear to be a profitable proposition for the large commercial operators, or the major public scheme in Paris (Autolib). Smaller examples may be better placed, but then expanding their presence on the market is quite challenging. A fundamental issue is the balance of capacity against customer service. Users greatly value the accessibility of vehicles as and when required (whether pre-booked or on-demand). To achieve a given level of service provision (% of times it is the right vehicle, right place, right time) requires a lot of capacity in vehicles and stations (for station schemes), and for those vehicles to be physically proximate. However, over-provision of vehicles results in lower utilisation rates because the vehicles are idle for too long. Under provision of vehicles results in loss of service, because users cannot access vehicles as desired or expected. Managing this relationship between capacity and user satisfaction while simultaneously growing the fleet of cars and the pool of users has proven to be uniquely challenging.

However, it is evident that car sharing does fulfil a range of potential mobility needs and, when integrated into wider transport and urban planning, can be part of a portfolio of transport solutions. Given the right conditions it is to be expected that car sharing schemes will grow, especially as the lessons are learned from previous schemes.

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

BIBLIOGRAPHY

ACEA. (2017a). Economic and Market Report. Retrieved from http://www.acea.be/uploads/statistic_documents/Economic_and_Market_Report_Q4_2017.pdf

ACEA. (2017b). New passenger car registrations breakdown by share of diesel. Retrieved from http://www.acea.be/statistics/tag/category/share-of-diesel-in-new-passenger-cars

ACEA. (2018a). CO2 from new cars up as petrol overtakes diesel, 2017 data shows. *ACEA press releases*. Retrieved from http://www.acea.be/press-releases/article/co2-emissions-from-new-cars-up-as-petrol-overtakes-diesel-2017-data-shows.

ACEA. (2018b). Alternative fuel vehicle registrations +35.1% in fourth quarter; +39.7% in 2017. Retrieved from http://www.acea.be/press-releases/article/alternative-fuel-vehicle-registrations-35.1-in-fourth-quarter-39.7-in-2017

ACEA. (2018c). Alternative fuel vehicle registrations. Retrieved from http://www.acea.be/statistics/tag/category/electric-and-alternative-vehicle-registrations.

ACEA. (2018d). Overview: tax incentives for electric vehicles in the EU. Retrieved from http://www.acea.be/publications/article/overview-of-incentives-for-buying-electric-vehicles.

Ambani, P. (2015). CarAmigo secures tax ruling: Car share earnings "not income." Retrieved from https://crowdsourcingweek.com/blog/caramigo-secures-tax-ruling-carshare-not-income/

Anderson, M. (2008) Safety for whom? The effects of light trucks on traffic fatalities, *Journal of Health Economics*, 27, 973-989.

Automotive-fleet. (2017). Electric Carsharing Service Launches in Bulgaria. Retrieved from https://www.automotive-fleet.com/142825/electric-carsharing-service-launches-in-bulgaria

Autovistagroup. (2018). Daimler purchases Europcar stake in car2go, paving the way for a merger with BMW's DriveNow, Retrieved from https://www.autovistagroup.com/news-and-insights/daimler-purchases-europcar-stake-car2go-paving-way-merger-bmws-drivenow, Accessed 26th April 2018.

Balac, M., Ciari, F. and Axhausen, K.W. (2017). Modeling the impact of parking price policy on free-floating carsharing: Case study for Zurich, Switzerland, *Transportation Research Part C: Emerging Technologies*, 77, 207-225.

Baptista, P., Melo, S. and Rolim, C. (2014). Energy, Environmental and Mobility Impacts of Car-sharing Systems. Empirical Results from Lisbon, Portugal, *Procedia - Social and Behavioral Sciences*, 111, 28-37.

Bardhi, F. and Eckhardt, G.M. (2012). Access-Based Consumption: The Case of Car Sharing, *Journal of Consumer Research*, 39(4), 881-898.

Behrmann, E. (2015). German Car-Share Boom Gives BMW, Daimler Dibs on Young Drivers, Retrieved from http://www.bloomberg.com/news/articles/2015-08-10/german-car-share-boom-gives-bmw-daimler-dibs-on-young-drivers, Accessed 12/11/15.

Becker, H., Ciari, F., & Axhausen, K. W. (2017). Comparing car-sharing schemes in Switzerland: User groups and usage patterns. *Transportation Research Part A: Policy and Practice*, 97, 17-29.

Belavina, E., Girotra, K. and Kabra, A. (2016). Online grocery retail: Revenue models and environmental impact, *Management Science*, 63(6), 1781-1799.

BCS. (2018). Car sharing in Germany, 1997 to 2018. Retrieved from https://www.carsharing.de/zahl-carsharing-kunden-ueberspringt-2-millionen-market

Bliss, L. (2018). Uber and Lyft Could Do a Lot More for the Planet. Retrieved from https://www.citylab.com/transportation/2018/04/how-uber-and-lyft-could-do-better-by-the-planet/558866/.

Bondarouk, E. and Liefferink, D. (2017). Diversity in sub-national EU implementation: the application of the EU Ambient Air Quality directive in 13 municipalities in the Netherlands. *Journal of Environmental Policy & Planning*, 19(6), 733-753.

Boogaard, H., Janssen, N. A., Fischer, P. H., Kos, G. P., Weijers, E. P., Cassee, F. R., ... & Brunekreef, B. (2012). Impact of low emission zones and local traffic policies on ambient air pollution concentrations. *Science of the total environment*, 435, 132-140.

Bosteels, K. (2016). VW transfers car share project Quicar to Greenwheels, Retrieved from https://www.retaildetail.eu/en/news/vw-transfers-car-share-project-quicar-greenwheels. Accessed 20/05/2018

Boyer, K. K. and Hult, G. T. (2005). Extending the supply chain: Integrating operations and marketing in the online grocery industry, *Journal of Operations Management*, 23, 642-661.

Cambio. (2018). Newsletter édition festive 2018. Retrieved from https://mailchi.mp/76283ca9047a/ftons-ensemble-le-15me-anniversaire-de-cambio

Car2go. (2017). An ever increasing number of car2go customers use carsharing transnationally in Europe, Retrieved from http://media.daimler.com/marsMediaSite/en/instance/ko/An-ever-increasing-number-of-car2go-customers-use-carsharing-transnationally-in-Europe.xhtml?oid=17329260. Accessed 29/05/2018

Car2go. (2018). White paper: Five reasons why carsharing plays a decisive role in the breakthrough of electric mobility. Retrieved from https://www.car2go.com/media/data/germany/microsite-press/files/car2go_white-paper_electric-mobility_2018.pdf

Cardenas, I.D., Dewulf, W., Vanelslander, T., Smet, C., and Beckers, J. (2017) The e-commerce parcel delivery market and the implications of home B2C deliveries vs pick-up points, *International Journal of Transport Economics*, 44(2), 235-256.

CarplusBikeplus. (2016). Shared Electric Bike Programme Report 2016. Retrieved from https://www.carplusbikeplus.org.uk/wp-content/uploads/2017/05/Shared-Electric-Bike-Programme-Final-Report.pdf accessed 28/05/2018

Carsharing. (2017). CarSharing-Städteranking 2017. Retrieved from https://carsharing.de/sites/default/files/uploads/rangliste_carsharing-staedteranking_2017.pdf

Cheng, K. (2017). Electric car-sharing service to hit roads in December, Retrieved from http://www.todayonline.com/singapore/80-electric-cars-30-charging-stations-under-first-electric-vehicle-car-sharing-scheme-dec. Accessed 6/10/17

Citybee. (2018). About CityBee. Retrieved from. https://www.linkedin.com/company/citybee-car-sharing

Cohen, M.J. (2012). The future of automobile society: A socio-technical transitions perspective, *Technology Analysis and Strategic Management*, 24(4), 377-390.

Coldwell, W. (2014). Airbnb's legal troubles: What are the issues? *The Guardian*. Retrieved from https://www.theguardian.com/travel/2014/jul/08/airbnb-legal-troubles-what-are-the-issues

Dablanc, L., Morganti, E., Arvidsson, N., Woxenius, J., Browne, M. and Saidi, N. (2017) The rise of on-demand 'Instant Deliveries' in European cities, *Supply Chain Forum*, 18(4), 203-217.

Davies, C. (2017). Bentley's future is transparent OLED and luxury car-sharing. Retrieved from https://www.slashgear.com/bentleys-future-is-transparent-oled-and-luxury-car-sharing-17472192/. Accessed 08/10/17.

Degraeuwe, B., Thunis, P., Clappier, A., Weiss, M., Lefebvre, W., Janssen, S. and Vranckx, S. (2017) Impact of passenger car NOX emissions on urban NO2 pollution – Scenario analysis for 8 European cities, *Atmospheric Environment*, 171, 330-337.

Department for Transport. (2018). Car statistics tables. Retrieved from https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars#table-veh0204.

Dowling, R. and Kent, J. (2015). Practice and public–private partnerships in sustainable transport governance: The case of car sharing in Sydney, Australia, *Transport Policy*, 40, 58-64.

DriveNow. (2017). Factsheet DriveNow, Press Release. Retrieved from https://content.drive-now.com/sites/default/files/2017-10/DriveNow_Factsheet_October_2017_General.pdf

EEA (2017). Premature deaths attributable to air pollution. Retrieved from https://www.eea.europa.eu/media/newsreleases/many-europeans-still-exposed-to-air-pollution-2015/premature-deaths-attributable-to-air-pollution.

EEA. (2018). No improvements on average CO2 emissions from new cars in 2017. Retrieved from https://www.eea.europa.eu/highlights/no-improvements-on-average-co2

European Commission. (2017). European Urban Mobility: Policy Context. Retrieved from https://ec.europa.eu/transport/sites/transport/files/2017-sustainable-urban-mobility-policy-context.pdf

ExpertEye. (2017). European Automotive Report 2nd Half 2017. Retrieved from https://experteye.com/pdf-download-for-2nd-half-2017-report/

Ferrero, E., Alessandrini, S. and Balanzino, A. (2016). Impact of the electric vehicles on the air pollution from a highway, *Applied Energy*, 169, 450-459.

Fioretti, J. (2018). Uber jumps into European bicycle-sharing market. *Reuters*. Retrieved from https://www.reuters.com/article/us-uber-jump-europe/uber-jumps-into-european-bicycle-sharing-market-idUSKCN1J20WE

Firnkorn, J. and Müller, M. (2015). Free-floating electric carsharing-fleets in smart cities: The dawning of a post-private car era in urban environments? *Environmental Science & Policy*, 45, 30-40.

Fishman, E., Washington, S., & Haworth, N. (2013). Bike share: a synthesis of the literature. *Transport reviews*, 33(2), 148-165.

Foucaud, I., & Kermanach,L. (2011). "Autolib' fâche les loueurs de voiture et les taxis parisiens". *Le Figaro*. Retrieved from http://www.lefigaro.fr/conjoncture/2011/12/06/04016-20111206ARTFIG00688-autolib-fache-les-loueurs-de-voiture-et-les-taxis-parisiens.php

Fratila, S. (2018). Bike sharing will change city life. Retrieved from https://www.donkey.bike/bike-sharing-will-change-city-life/.

Fulton, L., Mason, J. and Meroux, D. (2017). Three Revolutions in Urban Transportation. Retrieved from https://www.itdp.org/wp-content/uploads/2017/.../UCD-ITDP-3R-Report-FINAL.pdf

Gelinas, N. (2015). Airbnb is a problem for cities like New York and San Francisco. *The New York Times*. Retrieved from https://www.nytimes.com/roomfordebate/2015/06/16/san-francisco-and-

new-york-weigh-airbnbs-effect-on-rent/airbnb-is-a-problem-for-cities-like-new-york-and-san-francisco

George, P. (2017) The Smart Car Is Eventually Getting Phased Out Of Car2Go In America, Jalopnik. Retrieved from https://jalopnik.com/the-smart-car-is-getting-phased-out-of-car2go-in-americ-1820414890. Accessed 22/05/18

Guildford, D. (2016). BMW's DriveNow is profitable now. Retrieved from http://www.autonews.com/article/20161003/GLOBAL/310039970/bmws-drivenow-is-profitable-now.

Guinet, E. (2018). Drivy and ARC Europe Group, roadside assistance leader, join forces through a unique global partnership. Retrieved from https://arceuropegroup.com/drivy-and-arc-europe-group-roadside-assistance-leader-join-forces-through-a-unique-global-partnership/. Accessed 20/05/18.

Gutiérrez, H. (2018, 7 March). As Uber plans Barcelona comeback, taxi drivers prepare for new battle. *El Pais.* Retrieved from https://elpais.com/elpais/2018/03/07/inenglish/1520414736_863124.html

Hickey, S., & Cookney, F. (2016). Airbnb faces worldwide opposition. It plans a movement to rise up in its defence. *The Guardian.* Retrieved from https://www.theguardian.com/technology/2016/oct/29/airbnb-backlash-customers-fight-back-london

Higgins, T. (2017) The End of Car Ownership, Retrieved from https://www.wsj.com/articles/the-end-of-car-ownership-1498011001, Accessed 25/06/18.

Holman, C., Harrison, R. and Querol, X. (2015). Review of the efficacy of low emission zones to improve urban air quality in European cities, *Atmospheric Environment*, 111, 161-169.

Hooftman, N., Oliveira, L., Messagie, M., Coosemans, T. and Van Mierlo, J. (2016). Environmental analysis of petrol, diesel and electric passenger cars in a Belgian urban setting, *Energies*, 9(2), 1-24.

HSL. (2016). Final report on the Kutsuplus trial: work to develop ride-pooling worth continuing. Retrieved from https://www.hsl.fi/sites/default/files/uploads/8_2016_kutsuplus_finalreport_english.pdf. Accessed 26/05/2018.

Institut des Experts-comptables et des Conseils fiscaux. (2016). Tarif TVA réduit pour système public de vélos. Retrieved from https://www.iec-iab.be/fr/membres/publication/actualite/Institut/Pages/20161220-Tarif-TVA-reduit-pour-systeme-public-de-velos.aspx

Jackson, T. (2004). Models of Mammon: A Cross-Disciplinary Survey in Pursuit of The 'Sustainable Consumer', Working Paper Series Number 2004/1. University of Surrey Centre for Environmental Strategy, Guildford, UK.

Jaconi, M. (2014). The 'On-Demand Economy' Is Revolutionizing Consumer Behavior — Here's How. Retrieved from http://www.businessinsider.com/the-on-demand-economy-2014-7?IR=T.

Ji, S., Cherry, C. R., Han, L. D., & Jordan, D. A. (2014). Electric bike sharing: simulation of user demand and system availability. *Journal of Cleaner Production*, 85, 250-257.

Jones, T., Harms, L., & Heinen, E. (2016). Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. *Journal of transport geography*, 53, 41-49.

Kopsch, F. (2012). A demand model for domestic air travel in Sweden, *Journal of Air Transport Management*, 20, 46-48.

Kopp, J. and Gerike, R. (2015) Do sharing people behave differently? An empirical evaluation of the distinctive mobility patterns of free-floating car-sharing members, *Transportation*, 42(3), 449-469.

Kraftfahrt-Bundesamt (KBA). 2017. New registrations of passenger cars in Germany. Retrieved from https://www.kba.de/DE/Statistik/Fahrzeuge/Neuzulassungen/Halter/z_n_halter.html?nn=652344

Kuhnimhof, T., Buehler, R., Wirtz, M. and Kalinowska, D. (2012). Travel trends among young adults in Germany: Increasing multimodality and declining car use for men, *Journal of Transport Geography*, 24, 443-450.

Kuhnimhof, T. (2017). Car ownership and usage trends in Germany – Response to the Commission on Travel Demand's Call for Evidence: Understanding Travel Demand. Retrieved from http://www.demand.ac.uk/wp-content/uploads/2017/03/25-EC1-Tobias-Kuhnimhof.pdf

Lloyd, C. (2017). Audi to roll out upmarket car sharing scheme. Retrieved from http://www.parkers.co.uk/car-advice/2017/audi-to-roll-out-upmarket-car-sharing-scheme/

Longhi, C., Mariani, M. M., & Rochhia, S. (2016). Sharing and tourism: The rise of new markets in transport. Documents de travail GREDEG—working paper series, (01).

Louvet, N. and Jacquemain, G. (2017). Autolib' is still not profitable and perhaps it never will be. Retrieved from https://6-t.co/en/autolib-not-profitable/.

L'Osservatorio Nazionale Sharing Mobility. (2017). Osservatorio Nazionale Sharing Mobility 2018. Retrieved from http://osservatoriosharingmobility.it/?page_id=14490

Lu, J.-L. and Peeta, S. (2009). Analysis of the factors that influence the relationship between business air travel and videoconferencing, *Transportation Research Part A: Policy and Practice*, 43(8), 709-721.

Marckx, J. (2016). Expertise Opérationnelle et Support Service TVA Taxe sur la valeur ajoutée Décision TVA n° E.T.131.027. Retrieved from https://www.iec-iab.be/fr/membres/publication/actualite/Institut/Documents/2016/D%C3%A9cision%20TVA%20n%C2%B0%20ET131027%20du%2016%2012%202016%20-%20Syst%C3%A8me%20public%20de%20v%C3%A9los.pdf

Martin, E. and Shaheen, S. (2011). The Impact of Carsharing on Public Transit and Non-Motorized Travel: An Exploration of North American Carsharing Survey Data. *Energies*, 4, 2094-2114.

Mayor of London. (2017). Mayor: Ultra-Low Emission Zone will start in 2019 to tackle toxic air. Retrieved from https://www.london.gov.uk/press-releases/mayoral/ulez-will-start-in-2019-to-tackle-toxic-air

McCarthy, N. (2016). Are high taxes crippling the car-sharing industry? *Forbes.* Retrieved from https://www.forbes.com/sites/niallmccarthy/2016/07/26/are-high-taxes-crippling-the-car-sharing-industry-infographic/#299d9595941f

Mckinnon, A.C. (2016) The possible impact of 3D printing and drones on last-mile logistics: An exploratory study*, Built Environment*, 42(4), 617-629.

McCracken, G. (1986). Culture and Consumption: A Theoretical Account of the Structure and Movement of the Cultural Meaning of Consumer Goods, *Journal of Consumer Research*, 13, 71-84.

Merella, A. (2008). Io guido car sharing. Retrieved from http://www.terranuova.it/News/Ambiente/Io-guido-Car-Sharing

Nijl, H. and van Meerkerk, J. (2017). Mobility and environmental impacts of car sharing in the Netherlands, *Environmental Innovation and Societal Transitions*, 23, 84-91.

Nussbaum, A. (2017). Shares of French billionaire's battery business have plunged. Retrieved from https://www.bloomberg.com/news/articles/2017-01-20/bollore-s-electric-car-venture-leaves-investors-on-side-of-road.

Pandaily. (2018). Mobike's Shared Cars to be Launched on the Bike-Sharing App Deliverable in October. Retrieved from https://pandaily.com/mobikes-shared-cars-to-be-launched-on-the-bike-sharing-app-deliverable-in-october/

Panteliadis, P., Strak, M., Hoek, G., Weijers, E., van der Zee, S., & Dijkema, M. (2014). Implementation of a low emission zone and evaluation of effects on air quality by long-term monitoring. *Atmospheric environment*, 86, 113-119.

Paundra, J., Rook, L., Janvan, D. and Ketter, W. (2017). Preferences for car sharing services: Effects of instrumental attributes and psychological ownership, *Journal of Environmental Psychology*, 53, 121-130.

Pitas, C. and Taylor, E. (2017). Drop in diesel car demand could put brakes on autos finance boom. Retrieved from https://uk.reuters.com/article/uk-autos-diesel-depreciation-idUKKBN1811EP

Prieto, M., Baltas, G. and Stan, V. (2017). Car sharing adoption intention in urban areas: What are the key sociodemographic drivers? *Transportation Research Part A: Policy and Practice*, 101, 218-227.

Qadir, R. M., Abbaszade, G., Schnelle-Kreis, J., Chow, J. C., & Zimmermann, R. (2013). Concentrations and source contributions of particulate organic matter before and after implementation of a low emission zone in Munich, Germany. *Environmental pollution*, 175, 158-167.

Ranieri, L., Digiesi, S., Silvestri, B., and Roccotelli, M. (2018). A review of last mile logistics innovations in an externalities cost reduction vision, *Sustainability*, Open Access, 10(3), Article number 782.

Regterschot, E. (2017). Amsterdam: The first low emission zone for mopeds by 2018. Retrieved from https://www.polisnetwork.eu/publicdocuments/download/2259/document/4d_regterschot.pdf

Reuters (2015). BMW's car-share service says 38 pct of clients abandon ownership. Retrieved from https://www.reuters.com/article/bmw-drivenow-displacement/bmws-car-share-service-says-38-pct-of-clients-abandon-ownership-idUSL8N0ZC3YR20150626, Accessed 27th April 2018.

Richardson, L. (2015) Performing the sharing economy, *Geoforum*, 67, 121-129.

Sachgau, O., Rauwald, C. and Coppola, G. (2018). Daimler, BMW Reach a Deal to Merge Car-Sharing Units, Retrieved from https://www.bloomberg.com/news/articles/2018-03-28/daimler-bmw-are-said-to-reach-deal-to-merge-car-sharing-units. Accessed 10th May 2018.

Sampson, J. (2018). Linde to close world's first fuel cell car sharing service, Gas World. Retrieved from https://www.gasworld.com/linde-to-close-worlds-first-fuel-cell-car-sharing-service/2014327.article, Accessed 28/05/18.

Schmöller, S., Weikl, S., Müller, J. and Bogenberger, K. (2015). Empirical analysis of free-floating carsharing usage: The Munich and Berlin case, *Transportation Research Part C: Emerging Technologies*, 56, 34-51.

Schwieterman, J. P., & Spray, H. (2016). "When sharing is taxing: Comparing the tax burden on carsharing services in major U.S. cities." Chaddick Institute for Metropolitan Development at DePaul University. Retrieved from https://las.depaul.edu/centers-and-institutes/chaddick-institute-for-

metropolitan-development/research-and-publications/Documents/WhenSharingIsTaxing-072116-final.pdf

Shaheen, S. A., & Cohen, A. (2015). "Innovative Mobility Carsharing Outlook: Market Overveiw, Analysis and Trends." Transportation Sustainability Research Center, University of Calironia at Berkely. Retrieved from http://innovativemobility.org/wp-content/uploads/2015/07/Summer-2015-Carsharing-Outlook_Final-1.pdf

Share-north. (2017). Results of Impact Analysis of Car-Sharing Services and User Behaviour Delivers Interesting Results in Bremen. Retrieved from https://share-north.eu/2018/05/results-of-impact-analysis-of-car-sharing-services-and-user-behaviour-delivers-interesting-results-in-bremen/

Sheller, M. (2004) Automotive emotions: feeling the car, *Theory, Culture & Society*, 21(4/5), 221-242.

Sivak, M. and Schoettle, B. (2012) Recent changes in the age composition of drivers in 15 countries, *Traffic Injury Prevention*, 13(2), 126-132.

Spero, J. (2018). Dockless bike companies want right to operate across London. *Financial Times*. Retrieved from https://www.ft.com/content/1feac6c6-65af-11e8-90c2-9563a0613e56

Statista. (2018). Leading car sharing services ranked by number of vehicles in Germany. Retrieved from https://www.statista.com/statistics/415310/car-sharing-services-number-of-vehicles-germany/

Transport for London. (2017). Travel in London: Report 10. Retrieved from http://content.tfl.gov.uk/travel-in-london-report-10.pdf

Transport & Environment. (2018). How to get rid of dirty diesels on city roads: Analysis of diesel restriction measures in European cities to date. Retrieved from https://www.transportenvironment.org/sites/te/files/publications/TE%20Air%20Quality%20Report_FINAL_12032018%20NEW.pdf

Urban Access Regulations in Europe. (2018). Access regulations in Europe. Retrieved from http://urbanaccessregulations.eu/

Val, E. (2017). A comparison of insurance options of selected online marketplaces. Retrieved from https://www.sharetribe.com/academy/insurance-options-online-marketplaces/. Accessed 19/05/18

Vanderheiden, S. (2006) Assessing the case against the SUV, *Environmental Politics*, 15(1), 23-40.

Vine, S. L., Lee-Gosselin, M., Sivakumar, A., & Polak, J. (2014). A new approach to predict the market and impacts of round-trip and point-to-point carsharing systems: Case study of London. *Transportation Research Part D-Transport and Environment*, 32, 218–229.

Vulog. (2018). One of the largest Volkswagen Group importers in Europe – D'Ieteren – launches new carsharing project, powered by Vulog. Retrieved from https://www.vulog.com/blog/2018/01/18/press-release-one-largest-volkswagen-group-importers-europe-dieteren-launches-new-carsharing-project-powered-vulog/

Waters. R. and Bradshaw, T. (2018). Uber joins bicycle-sharing peloton with Jump Bikes deal. *Financial Times*. Retrieved from https://www.ft.com/content/f513c4b8-3ba9-11e8-b9f9-de94fa33a81e

Wells, P. (2006). *Off-road car on-road menace*, London: Greenpeace.

Wells, P., and Nieuwenhuis, P. (2015) EV business models in a wider context: balancing change and continuity in the automotive industry, Chapter 1 pp3-16 in Beeton, D. and Meyer, G. (eds) *Electric Vehicle Business Models – Global Perspectives*, Heidelberg: Springer.

Wells, P. and Xenias, D. (2015) From 'freedom of the open road' to 'cocooning': understanding resistance to change in personal private automobility, *Environmental Innovation and Societal Transitions*, 16, 106-119.

Zhaw. (2018). Shared Mobility Comparison collaborative mobility services in European cities. Retrieved from https://www.zhaw.ch/storage/hochschule/medien/shared-mobility-engl.pdf