

Notes from a Workshop on Future Directions in Modelling Car Share Schemes

Date: Tuesday 09 January 2024, 10.30 - 16.00

Venue: [Council Room](#), King's Building, Strand campus, Kings College London, WC2R 2LS

We are grateful for funding from the Engineering and Physical Research Council UK under grant number EP/Y008014/1 which enabled this workshop to take place.

The project

This EPSRC-funded project will develop mathematical tools to deliver a more financially sustainable car sharing service, acting as an exploratory phase to investigate the use of mathematical modelling and initiate discussions with stakeholders to better understand the challenges of running car share schemes. The models and knowledge acquired during this project will form the basis of a larger scale project aiming to design better demand models that support the financial sustainability of mobility as a service and investigate how these services may operate in urban and rural contexts. They will lay the groundwork for the ambitious goal of designing a digital twin for car sharing systems. The project will last for 12 months from November 2023.

Purpose of the workshop

The workshop was designed to inform the scope and specification of the project, exploring current best practice, capturing learning from previous and current car share services, identifying research priorities, and establishing key measures of success.

Objectives

- To devise a problem specification for large-scale car share schemes.
- To gain an informed understanding of the state of car share across the UK.
- To learn from the experiences of existing services.
- To scope a larger project and investigate interesting new research directions.

Attendees

Name	Affiliation
Rym M'Hallah	King's College London
Christine Currie	University of Southampton
Dong Li	Lancaster University
Richlove Frimpong	King's College London
Selin Ahipasaoglu	University of Southampton
Chiara Calastri	Institute of Transport – Leeds University
Eran Livne	Institute of Transport – Leeds University
Mark Palmer	Southwark Council
Hedley Mellor	Southwark Council
Keith Kelly	Enterprise
Eleonore Kuentz	Hiyacar
Elliot Quinn	Lambeth Council
Hannah Byk	Better Points UK

Robert Schopen
Joseph Duggan
Alina Tuerk
Dimitrios Letsios
Xinan Yang
Iain Steele (absent due to illness)
Nilesh Patel
Ben Rees
Haoxiang Wang

Co-Wheels
TfL
TfL
King's College London
University of Essex
Royal Borough of Kensington & Chelsea
Oxford City Council
University of Southampton
King's College London

Introduction to the Project

Professor Rym M'Hallah introduced the project and presented some initial results on optimal pricing (see presentation – Car Share Workshop January 2024.pdf).

Post Presentation Discussion

Car share service providers present at the workshop estimate demand to be approximately 25% for whole day bookings and 75% for hour-by-hour bookings. They provide Peer to Peer (P2P) and back to base services. There was also a belief that duration was likely to vary seasonally and be longer for the round-trip hires than for the one-way hires.

The providers estimate that the one-way hire (or flex) model is neither financially attractive nor environmentally sustainable as it increases car use. One provider stated the fact that it is unsustainable as a reason why they do not offer one-way hires. A company operating on a flex model would need a very different pricing model in order to optimise their financial sustainability. The flex service could be more convenient to users but is neither attractive to stakeholders nor to users. 'It is more expensive than an Uber.' Their opinion was that back to base or round-trip is the model to consider. There was an acknowledgement that the flex model is in competition with public transport and is not environmentally friendly.

The flex model also faces regulatory challenges. For instance, local regulations, e.g., London is split into 32 boroughs, each charging different fees; this makes the flex model difficult to implement. There was also concern from the car share operators that the rules and economics between city to city differ wildly, and a general model that could apply to all cities would be unrealistic.

It is also important to understand patterns and cultural backgrounds to promote changes towards more sustainable modes of transport. There was some agreement from the council representatives that subsidies could be used to support this. There is a challenge in finding a balance between promoting car sharing as a feasible alternative to car ownership and establishing reasonable revenue for councils from permits and procurements. Fees associated with parking, maintenance, insurance, risk of accident, and idle time constitute a large portion of the cost to service providers.

The flex car share model tends to have a minimum booking duration of 30 minutes, but the journey may not take 30 minutes. Some statistics on car share (from a provider of round-trip/back-to-base hires): During December 2023, a shared car was on average rented 18 times by 18 people with shortest ride taking 1-hour, average ride for 8.6 hours and maximum ride time was 46 hours. In miles, the shortest ride was for 7 miles while the longest ride was for 420 miles.

Autonomous cars won't be ready for use for a while so don't impact on current thinking.

From a data analytics viewpoint, the data used to select parameters from the model has to be relevant. Data collected on consumer habits during the years of the COVID-19 pandemic (2020 – 2021) acts as a strong outlier when considered with previous years. This shift in consumer habits

during the pandemic is largely explained by people working from home, which led to a decrease in utilisation of car hires. There was also a belief among attendees that consumer behaviour will continue to be affected in the future.

Main Takeaway: The main takeaway from this small Q&A was that looking at a round-trip or return-to-base model would be the most commercially viable for car share operators and consequently more popular. A pricing model that utilises a mix between commercial hires and business hires could also be of interest and addressing the challenge affecting councils of promoting car share but maintaining revenues.

Challenges and Opportunities for Car Share Schemes

Joseph (TfL)

Challenges: Complex operational environment and lack of visibility

- 80% of trips are made by sustainable transport, and car sharing is assumed to be part of sustainable transport.
- TfL are opting for semi-flex as a substitute to private cars but what incentives are really in place?
- Correctly dimensioning space and parking is a challenge as London Boroughs make their own choices in terms of policies and parking (both in terms of availability and costs), and access to EV chargers. Some boroughs require service providers to pay for the installation of electric battery chargers, a hefty investment. In addition, shared cars compete with private cars for chargers.
- Important aspects in addition to public messaging is data sharing and visualization of the availability of shared cars.

Eleonore (Hiyacar)

Challenges: Operational environment is difficult.

- There is a lack of cohesion in London and across the UK. Different boroughs apply different procurement practices of car clubs. The contracts between the boroughs and the service providers are relatively short term (3-5 years) while buying or leasing a car is a longer-term investment.
- Costs are very high whereas margins are very slim. Costs include purchase or lease price, cost of investment, fuel prices, council permits' costs, insurance, maintenance, overhead, and liability (very challenging). In some boroughs, council permits' costs are 20 times higher than a resident parking permit.
- Car sharing requires scaling to become financially viable and absorb losses. Rapid scaling is needed for it to be commercially sustainable.
- There is a pressure to electrify the fleet but there is no charging infrastructure available.
- Different use patterns during the weekend and weekdays.
- High entry costs make it difficult for competitors to enter the market (buying rather than leasing cars is a better business model but increases entry costs).
- The UK has a big *car culture*, more so than mainland Europe. Car share currently has a very low proportion of the market in the UK.

Opportunities: Cost of private car ownership and availability of new technologies

- High prices of owning and using private cars are driving people not to own a car and to sell their second cars if they own more than one car.
- ULEZ
- EVs are very expensive for one person to buy; making sharing a car more financially attractive.
- Increasing costs of residential parking permits driving Londoners not to own a car.
- New technology such as facial recognition, scanning of driving licenses, unlocking a car, global positioning system of cars, etc. are reducing fraud and improving the ease-of-use of car sharing.

Nilesh (Oxford City Council)

Oxford has over 50 car clubs, 15 of those being electric vehicles. They offer accessibility and mobility to low-income families. Inclusivity and accessibility are another goal of shared car services. Car sharing can be seen as an intermediary step towards increased use of electric vehicles (EVs).

Challenges: regulation and conflicting priorities

- Schemes are county-led as the city council does not own the highways.
- Lack of EV provision and infrastructure
- One-way is impractical: time to reallocate cars to bays is a downtime to car clubs leading to loss of revenue.
- Conflicting priorities between service teams at councils: revenue generation versus net-zero goals (e.g. maintaining revenue to the council when there is a reduction in parking income due to fewer cars being driven into the city centre).

Opportunities: user benefits

- Car share clubs offer the opportunity to users to transition to adoption of EVs.
- Car share clubs are part of the park and ride scheme, which promotes public transport.

Robert (Co-Wheels)

Back to base (or roundtrip) is the preferred business model.

Challenges: A non-standard procurement model and downtime caused by insufficient infrastructure.

- A different regulatory approach is needed before we will start seeing a shift towards car sharing.
- Reducing downtime is key. Charging time decreases already slim margins.
- To break even, a service provider needs:
 - on average about 18 months as set up time for membership enrolment and people adopting the service.
 - At least 50 cars; preferably 100-200 cars in the fleet within a London borough.
- The UK needs a formalized procurement process as in Germany instead of the current one-to-one negotiation.

Opportunities: parking and congestion issues make private car ownership less attractive.

- Parking and congestion issues
- High running costs of private cars

To support the roll out of car sharing there is a need for tools that measure the potential of an area for car sharing including:

- structural infrastructure (such as parking spaces, charging, bays),
- population size and structure,
- population density of coverage area,
- demand type (rural versus urban), frequency (occasional, regular, weekday, weekend, purpose of journey), limited versus varied,
- potential demand,
- running costs accounting for demand type and population (accounting for risks).

Hannah (Better Points UK)

It is important to understand patterns and cultural backgrounds to promote changes towards more sustainable modes of transport.

- When designing a model for optimising financial sustainability in car share schemes, it is important to understand the reason for a person's journey and to consider why people may make certain journeys
- Cultural and political changes are needed to ensure that consumers switch to more sustainable forms of transportation.
- In order to make these cultural changes, institutions need to communicate more sustainable travel choices, e.g. where shared car schemes are and how people can use them.
- Incentivising consumers to make the switch to sustainable travel is also crucial.
- The collection of and open access to data on consumer habits when it comes to sustainable travel and car share schemes is essential if we are to see any change in people's travelling habits.

Keith (Enterprise)

Car rentals are typically used for particular occasions, while car clubs or car sharing tend to be used in regular activities (e.g. shopping).

Opportunities: changing the way car sharing is viewed by the public.

- Car sharing should be seen as a "road pricing model", where consumers who rent from car share operators are paying for the impact they make. In hiring a car, the customer is making a conscious decision to take up road space and reduce emissions.
- Car share operators are providing mobility to customers.
- Autonomous vehicles provide an opportunity but will eradicate the flex/one-way hire model. Future research should focus on the round-trip/return-to-base model.

Mark (Southwark Council)

There are around 200 shared cars operating in Southwark currently, intending to increase to 500 in the near future.

Challenges: procurement processes and revenue

- Procurement processes are lengthy.
- Lack of revenue: average permit revenue in Southwark is £25-225 per year and average permit for shared car is £1500. A shared car replaces 23 private cars. So, the council charges

the service provider for 25 parking permits per car to ensure no loss in revenue. The loss in revenue from parking and other charges will make it less appealing for councils to fully embrace car sharing.

- Insurance costs and liabilities are high for car sharing operators, reducing their margins.
- Charging cost are 2.5 to 4 times higher than home energy prices because of the price cap.

Opportunities:

- Making car sharing more attractive to the 25-34 age group, particularly parents.
- Better advertising of the cost-benefit of switching from owning a private car to using a combination of public transport and a car club.

Hedley (Southwark Council)

The aim of sustainable travel should be to reduce overall travel.

Challenges:

- The growth of car sharing requires a lowering of costs that are passed on by the councils as the margins for car share operators are currently too small to pass on savings to the consumer.
- Car ownership can be more cost-effective for some people, but it would be useful to provide a calculator to allow people to evaluate costs for their lifestyle.
- The car sharing fleets are typically homogeneous, made up of small cars. This could reduce the number of people and journey types that they can support.

Opportunities:

- There are many areas of the UK (e.g., the West Midlands) which are very underdeveloped in the car sharing market.

What to Offer? User-Based Booking and Relocation Strategies for One-Way Carsharing Services. (Dong Li)

Professor Dong Li gave a presentation on recent research in car sharing (choice based car sharing latest.pdf)

Post-Presentation Discussion

Replaceable batteries and EV charging:

- Replaceable batteries were trialled in Spain. There have been some UK trials of induction charging. There was some scepticism about how useful they would be in the car sharing market.
- Modifying a fleet of vehicles to have replaceable batteries or inductive charging was not cost efficient, as ex-rental cars are typically sold on the second-hand market, and modifying the cars would severely reduce their resale price.
- Induction charging was not smooth: technical difficulties and issues with other cars parking in inductive bays.
- Users are given two options when hiring an EV: concierge hire (an employee charges the car); or self-hire where the user hires the car themselves. Some work could be done on incentivizing consumers to charge their cars.

Round Table Discussions

The workshop was split into groups to discuss five questions:

Question 1. How does car share work outside urban areas?

Outside central London, typically only a round-trip model is offered, with characteristics listed below.

- Not a continuous user zone; unknown typography and uncertainty on land use
- Demand for private cars is too high for car share to work where there is a lack of shared mobility services and public transport alternatives.
- Frequency of need.
- Reverse path and ride
- Geared toward places where people need to travel but not super frequently.
- Must be driven and coordinated by local government.
- The higher the utilization, the lower the cost.
- Higher potential in islands and touristic areas and peri-urban areas that are outside of the 'ring'.
- Car clubs are funded by councils when outside urban areas.
- In rural areas accessibility is not guaranteed. Responsiveness is difficult.

Models

- Urban car share models
 - Currently back to base (maybe Zipcar is an exception?)
 - Commercial partnerships important for viability; councils' role is eminent.
 - Commercial memberships exist.
- Rural areas
 - Peer to peer (P2P) model does not require high utilization.
 - Non-urban model: Closed P2P and internal policies (e.g., no refuelling needed); community based with a heavy reliance on technology (e.g., for security checks).
 - Costs are limited to mileage and fuel in this case; so, low utilization is not an issue (as it is for club cars).
- Operators of car clubs do not believe shared cars will ever replace car ownership. They may replace the second car in the driveway.
- Most operators would opt for back to base with some exceptions in non-urban areas (mainly making users move cars for the weekend demand or for the week demand).
- Popular with users from HMRC, NHS, etc.: mixture of Business to Business and Business to Consumer use.
- Usage
 - Advanced booking can be cancelled up to 24 hrs prior to time of pick up.
 - Earliest start of weekend use is Thursday but usually Friday afternoon. For Xmas, rental started on December 19 (earlier than usual).
 - Weekend rate: £100/day; weekday rate: £60/day. Additional £40/day for insurance and booking fees.
 - Operating margins are slim: £500/year. This requires a balance of shorter versus longer rides.

2. Major unanswered questions in car share?

Operating Car-Share

- Does rebalancing become more cost-effective for a dense network of car sharing bases and increased demand?
- What is the long-term impact of electrification of the fleet?
- When should the car share fleet be increased to cater for residents of new buildings / developments?
- Can car sharing make money and can we predict which areas it will be feasible in? Possible factors: housing type, demographics, active travel rates and infrastructure availability, population density, membership (suggested minimum 30 members for a car club to be sustainable)

Regulation and Governance

- What are we doing with carsharing? Does car sharing have a socioeconomic mission or does it seek profitability?
- How can transport policy and private businesses drive regulation?
- How do you ensure councils get enough revenue while supporting car clubs (bay, parking, permit costs, charging points, etc.) without penalizing car owners?
- How do you ensure a fair allocation of costs among councils, service providers, and users while targeting net zero goals?
- Is collaboration between service providers feasible? Profitable? Attractive to them and to users?
- How to assess the impact of an additional car share on congestion and public transport?

3. Growth potential of car share?

No dynamic pricing models exist for car share operators, and councils prefer to operate a fixed rate model when working with car share operators. The argument that a dynamic pricing model could be advantageous in opening up car share schemes to low-income areas was made in favour of dynamic pricing.

Growth potential is huge in urban areas, particularly where access to public transport is limited. If charging of electric batteries becomes more efficient this could improve the potential for growth.

One-way flex hires increase demand but require cross- borough collaboration and coordination.

Car sharing is moving beyond early adopters and is becoming part of a hybrid model involving share a ride, car share and splitting lift shares.

Car sharing is perceived as expensive. Adoption requires a shift of thinking via a national framework / vision that incorporates logistics, energy pricing, policy, improvements in technology for EVs and recharging infrastructure.

Growth depends on incentives: good service at low price to users and low cost to service providers. This links back to how much councils should charge for parking permits, how many parking spots and charging points to provide to support car clubs while meeting their net-zero targets. A pricing problem for councils!

Another growth potential brought up was TFL's idea of the growth of car share was car share in conjunction with a reduction in private car parking.

4. Major disruptors to current car share model?

Changes are needed to the perception of a car as a status symbol, particularly in towns (rather than cities). There is a lack of data on private car ownership particularly outside London.

Autonomous vehicles will enhance car share but may not be available for the next 45 years. Electrification of the fleet will come sooner, along with changes in the cost of leasing.

Car sharing is disruptive to private car usage for short journeys but hard to substitute for hard to make journeys.

There may be changes in the number of people with skills to use a car.

Suggestion of a national car club, which manages the license checks, etc. There could be an opportunity to see how a pricing model for car share would work under this scheme.

There was a talk about the current state of the charging network being very fragmented and that you require multiple RFID cards for each charging service, and if there was any way of unifying this network to make it easier for the consumer. This has relevance to car share as well as the use of electric cars in general. The electrification of vehicles means that car share models could be disrupted by future policy changes – an important question may be how you make a pricing model robust to such policy changes.

Incorporation of ride share with car share and a better understanding of peer to peer (P2P) could be areas to research to improve uptake. Implementation and the accompanying legislation may be difficult to manage.

5. What incentives are useful for encouraging the use of shared services?

There was some positive discussion of looking at car share schemes under a variable pricing model taking into account geographic and socio-economic parameters instead of purely on a fixed rate.

Other incentives could include mobility credits, discounts on use, links to alternative transport modes. Operational trust, time savings, and reliability are also important.

Takeaways

- Lack of a cohesive framework.
- Need for a digital twin and for a visualization tool.
- Lack of charging infrastructure while service providers are required to make long-term commitments to space, parking, and fleet size.
- Long procurement approach making responsiveness to demand a lengthy procedure (6 months on average to put a shared car to service).
- Revenue generation versus net-zero goals of councils.
 - How much should a borough charge for a parking permit to car owner and car clubs?
 - How can a council recover the financial losses caused by a decreasing income coming from resident parking permits?
- Lack of assessment tools.
 - Where to position car club bays? What type of charging points and where to position them?
 - How to assess (may be via simulation) the impact of an additional shared car on a borough?
 - How to assess the impact of an additional housing complex on transport?
- Understanding where car share sits within the personal transport sector. Is it a more convenient version of car hire, a one-for-one replacement for owning a car, and new part of public transport? Answering this has a major impact on the shape of future regulation.
- A need for a revenue sharing model.

Choice modelling for car share

Professor Selin Ahipasaoglu gave a research presentation (Ahipasaoglu_KCL Jan 2024.pdf).

Post-Presentation Discussion

Time complexity of the methods can be reduced by using moderate-sized instances.

AGENDA

Tea, coffee, and pastries		10.00 - 10.30
Welcome and introduction	Research Team	10.30 - 10.45
Introduction to project (20 mins) + Q&A (10 mins)	Research Team	10.45 - 11.15
Plenary: Challenges and opportunities for car share schemes Each attendee spends 5 minutes describing challenges and opportunities from their perspectives.	All attendees	11.15 - 12.30
Lunch		12.30 - 13.15
Plenary talk: What to Offer? User-Based Booking and Relocation Strategies for One-Way Carsharing Services	Dong Li	13.15 - 14.00
Roundtable discussions (with coffee) to answer questions: • How does car share work outside of urban areas? • Major unanswered questions in car share? • Growth potential of car share? • Major disruptors to the current share model (e.g., autonomous vehicles)? • What incentives are useful for encouraging the use of shared services?	All attendees	14.00-15.00
Feedback from roundtables	All attendees	15.00 - 15.20
Choice modelling for car share	Selin Ahipasaoglu	15.20-15.40
Sum up and close	Research Team	15.40 - 15.50