A New Paradigm for Urban Mobility
How Fleets of Shared Vehicles Can End the Car Dependency of Cities
Cities and CO$_2$

Global emissions are concentrated in urban areas

5% of world’s land mass

70% of global CO$_2$ emissions

World Cities

Cars in cities

Motorisation of Beijing (China) between 1997 and 2017

1997: 1M cars
2004: 2M cars
2007: 3M cars
2017: 6M cars
The issue

Car dominance in urban mobility

Mobility is an important component of human activity. It enables citizens to access their workplaces, hospitals, schools and other public services; it allows them to see friends, go to the cinema or travel abroad. In cities, mobility plays a particularly central role for ensuring prosperity and social cohesion in a context of high population density and intense economic activity.

Yet mobility is also a source of major problems for urban areas. In highly motorised and car-dependent cities especially, congestion, air pollution, noise and other externalities associated with moving people and goods can be considerable. Evidence for the costs of congestion is abundant: In greater Los Angeles travellers spend an average of 70 hours per year in traffic, wasting more than 200 litres of fuel. Air pollution causes considerable damage. The World Health Organization estimates that 88% of the 3.7 million premature deaths due to air pollution occur in low- and middle-income countries, with the greatest burden falling on Asia, where most of the cities with dramatically rising motorisation rates are located.

The trend towards urbanisation observed in the past decades is here to stay and will even accelerate. By 2050, two-thirds of the world population will live in urban settlements. Urban centres currently occupy less than 5% of the world’s landmass, but they account for around 70% of both global energy consumption and greenhouse gas emission.

Increasing disposable incomes in many countries have put buying a car within the reach of millions of people who previously relied on simpler forms of transport. As cities are centres of wealth creation, urban areas motorise particularly rapidly. Beijing took 48 years to reach the first million automobiles (in 1997), but only six years to reach the second million and four years more to attain 3 million. By 2017, Beijing’s roads will accommodate six million cars, with car licensing already heavily regulated and restricted. Similar developments abound, and even in low-income countries, private cars are becoming the dominant mobility choice.

The supremacy of the car in combination with low occupancy rates of less than 1.5 passengers per trip in many cities has severe impacts: Environmental degradation and climate change as a result of the dependence on fossil fuels; lost economic activity due to congestion; social exclusion of citizens where activities can only be accessed by car; as well as the human suffering and economic cost from the deaths and serious injuries caused by road crashes.

Three attributes of the private car give it a clear advantage over other transport options: flexibility, comfort and availability. These characteristics overshadow the advantages of other modes in the eyes of users, leading to a bias in favour of the private car.

Despite active promotion of public transport by most cities - for instance through expansion of existing subway systems or the introduction of new mass transport systems like Bus Rapid Transit (BRT) and Light Rail Transit (LRT) - it continues to lose market share to private vehicles in low- and middle-income countries. Developed countries have succeeded in slowing down the trend towards more use of private cars by expanding public transport networks but have been unable to reverse it.
Why shared mobility is good for the environment

Private cars vs. Shared vehicles

- **Private cars:**
  - 50 min.
  - 1.2 passengers
  - Average occupancy* (1.2)

- **Shared vehicles:**
  - 13 hours
  - 2.3 passengers
  - Average occupancy* (2.3)

*Private car average occupancy given for the city of Lisbon, the baseline scenario for the shared mobility scenario. Rates for other developed cities are in a similar range, e.g. Sydney 1.3, Athens 1.3, London 1.5, Singapore 1.6. Average occupancy for shared vehicles obtained from simulation in both ridesharing scenario as well as ridesharing and taxibus scenario.
The main policy approaches to mitigating urban mobility problems are summarised in the triad “Avoid, Shift, Improve”. “Avoid” policies aim to influence demand in ways that reduce the need for motorised travel. “Shift” policies promote and incentivise the replacement of carbon-intensive (and in other ways problematic) forms of transport with more sustainable mobility options. Finally, “Improve” policies focus on deploying better technologies and reorganising the supply of mobility in ways that reduce the external costs of transport.

Technological efforts on the “Improve” dimension have concentrated on finding cleaner sources of energy and developing more energy-efficient vehicle engines. Technology-driven mitigation tends to be effective in the short term. However, the overall impact in the long run might be small or even negligible if the global trend of dramatically growing transport demand continues.

“Avoid” policies that make motorised travel unnecessary can harness technological progress in different ways, for instance by making it easier to work from home (“telework”). Urban planning and land-use regulations which encourage high-density and functionally diversified development can make car trips redundant by reducing the distances between workplaces, homes, shopping and leisure activities. Concepts like “Transit Oriented Development” (TOD), which emerged in the United States over the past few decades, aim to develop “smart growth” areas with mixed land uses that are compact and walkable, usually around rail stations.

“Shift” policies to encourage the transition from motorised urban travel towards public transport, walking, cycling and other more sustainable options have shown greater and quicker results than the “Improve” or “Avoid” approaches.

Many cities have introduced systematic Travel Demand Management (TDM), a set of measures that range from providing users with travel information in real time, moral appeals to behave in a more environmentally responsible way or creating financial incentives for using sustainable transport modes. Congestion charges in cities like London, Milan, Singapore or Stockholm are examples of increasing the cost of urban car use. The city of Paris encourages the shift away from cars with a cash subsidy of up to EUR 400 on the purchase of an electric bicycle.

A more recent phenomenon is the use of private cars to provide quasi-public transport in the context of a digitally-driven “shared economy”. Carsharing has been around for decades, but as a niche phenomenon. Now the omnipresence of mobile digital devices brings together supply and demand in real time and on an unprecedented scale. This makes a market for shared mobility more viable - and more relevant for policies that aim to shift mobility patterns.

Private cars are idle for more than 23 hours of the day on average. They are mostly used during the same time of the day, creating congestion. Their occupancy rate during trips is very low. Despite these inefficiencies, cars remain highly valued assets and car users accept the costs associated with them – high capital costs, delays and unreliable travel times, pollution, noise, climate change – in return for comfortable, door-to-door and schedule-free travel.

Mobility based on shared cars can preserve the levels of comfort and flexibility associated with private vehicles, while requiring fewer vehicle trips to meet travel demand. Vehicle sharing thus has the potential to bridge the gap between giving users what they value in a private car while providing a way to provide these benefits in more efficient ways and at lower personal and societal cost.

But how would a system of shared car-based mobility need to be set up so it can deliver these benefits in an urban environment? Ubiquitous internet access and dedicated app-based services have already spawned popular and sophisticated shared mobility services around the world for carpooling, carsharing and ride sharing. Two transport alternatives have been less in focus: shared taxis, where different passengers or parties use the same for-hire vehicle for all or part of their ride, and taxibus services, i.e. on-demand minibus services that expand the conventional concept of regular bus lines beyond fixed routes and fixed schedules.
Improving cities with shared vehicles

The insights
How to take 9 out of 10 cars off city streets

Several studies have explored how shared mobility services could change urban transport. The scenarios examined range from shared vehicle fleets as an additional service to the existing mobility market, to scenarios where shared vehicles replace private cars in a city and provide all motorised mobility.

The International Transport Forum (ITF) developed a simulation platform to explore different configurations of shared transport solutions for cities. The model reproduces the interaction between users and shared mobility options in a realistic network and thus allows insights into the performance such a system should deliver. By accurately describing hypothetical shared mobility supply and mapping it against current mobility demand, the model can provide high-level indicators for transport policy decisions.

Importantly, the model respects citizens’ known behavioural preferences and mobility profiles. For instance, the need to transfer in order to reach a destination is known to reduce the willingness to switch to public transport. The model’s specifications therefore provide transfer-free trips from origin to destination and generally ensure a high level of acceptance among current car drivers by providing shared services that deliver flexible, comfortable and readily available mobility.

The model’s shared taxis are eight-seater minivans rearranged to seat only six passengers and with easy boarding/alighting for comfort. The shared taxis can be booked in real time and provide a door-to-door service. Users accept small detours from their original direct path.

The taxibuses used in the model have either 8 or 16 seats. They must be booked 30 minutes in advance and collect or drop off passengers no more than 300 metres from their origin or destination. Collection takes place within a ten-minute tolerance around the preferred boarding time.

In the simulation, shared taxis and taxibus services completely replace current motorised road transport (car, motorcycle, taxi and conventional buses).
In other words, all car users in the model city switch to either the new shared services or to walking/biking and metro/rail transport. The model was tested for the city of Lisbon, for which detailed mobility data is available. Against Lisbon’s current mobility pattern as the baseline case, three scenarios were analysed:

- **Simple Modal Diversion scenario**: In this scenario, trips by both private car and taxi are all taken over by shared taxis. All current trips by public transport (bus, metro, rail), continue to be made as before.

- **Ridesharing scenario**: Under this scenario, users chose between the options walking/cycling, metro/rail and shared taxis.

- **Ridesharing plus taxibus scenario**: This scenario gives users the additional choice of taxibus services as a mobility option.

In the baseline scenario, i.e. the current, real traffic pattern in Lisbon, the private car dominates with a share of 50% of passenger-kilometres or more. Public transport (bus, metro) represents a share of around 20%. The average occupancy rate for cars in Lisbon is 1.2 passengers. Occupancy levels for public transport are also low on average for the whole day, resulting in 13 passengers for a bus with 80 places. This leads to low service frequencies and long travel times compared with car travel. This mobility pattern leads to high vehicle-kilometres and high CO\textsubscript{2} emissions.

The introduction of the shared mobility options has significant impacts in all three scenarios. In the Simple Modal Diversion scenario, total daily vehicle-kilometres driven are reduced by almost a quarter (24.2%) and only slightly less (22.9%) in the Ridesharing plus taxibus scenario. In the Ridesharing scenario, vehicle-kilometres still drop by almost one-fifth (18.2%).

The impact on CO\textsubscript{2} emissions is in the same order of magnitude. In the Ridesharing scenario, motor-vehicle emissions are one fifth lower, at
Before
Parking space for under-used cars takes up large amounts of city space

After
Public space for more greenery, wider sidewalks, bicycle lanes, easier goods delivery

Shared fleets free urban space
only 79.6% of the baseline case. The Simple Modal Diversion leads to the smallest reduction of CO$_2$ emissions, but still lowers these by 18%. The Ridesharing plus taxibus scenario shows the strongest reduction of all scenarios, with only 71.9% of the current daily emissions. In other words, a city, reduces its emissions from motorised transport by almost 30%, if private car and scheduled bus travel is replaced by shared taxis and taxibus services.

Key to these reductions in both vehicle-kilometres driven and CO$_2$ emitted are high occupancy levels. The average occupancy rates achieved almost doubles (from 1.2 to 2.3 passengers) for shared taxis in both the Ridesharing and Ridesharing plus taxibus scenarios. The efficient allocation of spare capacity in the shared fleet makes it possible to provide the same mobility with dramatically fewer cars: In all three scenarios, the number of shared taxis and taxibuses required was only about 5% of the current fleet of private cars. In other words, the introduction of comprehensive shared mobility services with a shared vehicle fleet could take more than 9 out of 10 cars off the streets of a mid-sized city like Lisbon.

Because shared vehicles, unlike private cars, are in motion most of the day, it becomes unnecessary to provide any public space for on-street parking. Fewer off-street parking facilities would also be needed and some could be converted to other uses. Alternative use of the freed space could be leveraged to further reduce urban emissions – most obviously by making walking and cycling more attractive through wider sidewalks and more bicycle paths, but also by increasing parks and green spaces or making urban goods delivery more efficient and less CO$_2$-intensive. Experience indicates that this freed space must be proactively managed in order to lock in the benefits.

The efficiency gains also reflect on prices: Both shared taxis and taxibuses would be able to operate without subsidy at an average user price per kilometre of about one-third of the current price for taxis and scheduled buses respectively.

The considerable emissions reductions reflected in the values above are achieved purely through shared mobility services and would not require any technological advances from what is currently on the market. Moreover, the introduction of a fleet of shared taxis and taxibuses would also help to accelerate the uptake of cleaner vehicle technologies. The vehicles of shared fleets would be utilised much more intensely than today’s private cars, with average utilisation rising from approximately 50 minutes to about 13 hours per day. Therefore, the operating life cycles of the vehicles will be shorter, enabling a more rapid renewal of vehicle fleets than today. New technologies would thus be introduced at a faster rate, delivering additional environmental benefits.

Ultimately, the amount of car travel, congestion and emissions in a city is determined by public policy. Transport policies can influence the type and size of the car fleet as well as the mix between public transport and shared vehicles. The promotion of new, technology-enabled forms of shared urban mobility offers cities opportunities to drastically reduce motorised mobility and its negative side
effects. It is even conceivable that a policy focused on creating shared fleets could completely obviate the need for private cars in cities and establish a new paradigm for public transport and urban mobility.

Looking ahead, further performance improvements of a shared fleet might be achieved through vehicle automation. Assuming that automated vehicles will become widely used in the medium-term future, the associated benefits can then also be realised here. Removing the human element from vehicle operation will vastly improve the safety performance of the shared fleet. Also, driving styles and performance of the vehicles can be controlled and thus incorporate eco-driving principles to minimise emissions.

Moreover, the system can be operated with minimum headways between vehicles, which could not be achieved in a safe manner with human drivers, potentially increasing road capacity and, to a degree, facilitating higher fuel efficiency as vehicles can move in each others’ slipstreams. Similarly, the use of electric vehicles for a shared mobility system could enhance the liveability of urban areas by eliminating direct car emissions and, if electricity comes from low-carbon sources, overall emissions.

Various other Intelligent Transport Systems (ITS) applications, when implemented as accompanying measures, could add to the performance of shared fleets and allow transport planners to fine tune overall system performance and operation. This may include traffic management systems which dynamically control vehicle paths rather than relying on conventional traffic signals; access-control and priority systems regulating flows of specific vehicle (or engine) types for specific areas and at specific times; and demand-management techniques such as pricing regimes and user information systems.

Further reading

International Transport Forum,
Urban Mobility System Upgrade: How shared self-driving cars could change city traffic
Paris, 2015
Green and Inclusive Transport

18-20 May 2016
Leipzig, Germany

www.internationaltransportforum.org/2016
itf.contact@oecd.org
6 PAPERS ON TRANSPORT POLICY YOU SHOULD READ FOR COP21