



Congestion Reduction in Europe: Advancing Transport Efficiency

MG-5.3-2014
Tackling urban road congestion

D5.1

A long term analysis of traffic congestion and car use reduction in major European cities: what policies and measures worked?

WP5 - Combating congestion and reducing levels of car use in European cities:
strategies, business models and guidelines

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1. Introduction

1.1 Background

CREATE identifies three distinct policy objectives, shown in Figure 1, which western European cities have tended to follow sequentially over many years of urban mobility planning.

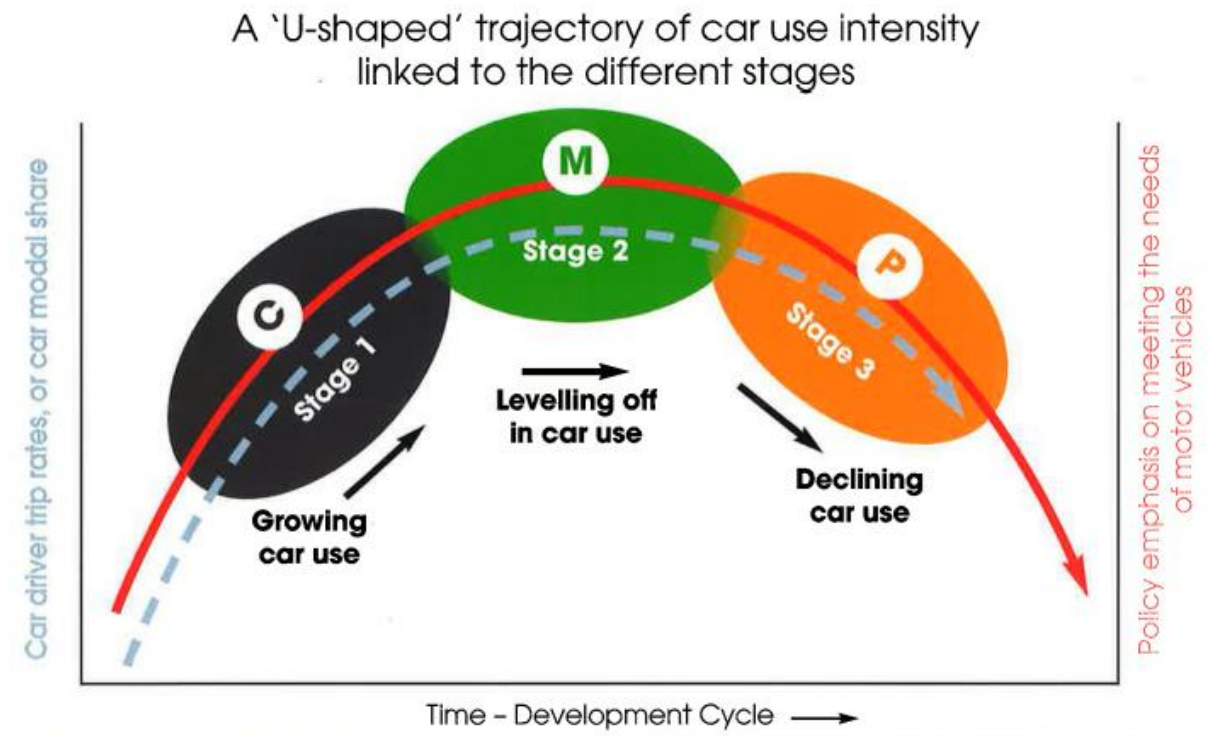


Figure 1: Evolution of city planning policies and impact on car use ¹

In Figure 1, the red arc represents the emphasis of city policy on meeting needs of motor vehicles. As this rises, so too does the car modal share, as represented by the blue arc. However, there is a time lag between the two, since it takes time for city policies to turn into implemented measures (such as public transport investment or road space reallocation). As the policy emphasis to accommodate motor vehicles falls, the theory suggests that so too does car modal share.

Stage 1: Car-orientated city (C)

This is where cities plan for moving cars (indicated by the red arc) and hence prioritise road building and car parking. This period sees a resulting increase in car use (indicated by the blue arc).

¹ "CREATE Project Summary and Conclusions for Cities. Urban Mobility: Preparing for the future, learning from the past" Peter Jones et al.

Stage 2: Sustainable mobility city (M)

This stage sees significant public transport investment to push forward the policy objectives of moving people, not cars. Road space starts to be reallocated away from car to accommodate public transport and cycling. As a result car use levels off thanks to the alternatives in place.

Stage 3: City of places (P)

Here we see road space continuing to be allocated to public realm, whilst cycling and walking infrastructure is expanded, traffic restraint measures implemented and mixed use developments reduce the need to travel. The policy objectives here are more geared towards liveability, health and quality of life. The result, as shown on the graph, is declining car use.

Berlin, Copenhagen, London, Paris and Vienna have all broadly experienced in recent decades the same sequence of policy objectives and resulting measure implementation.

These three stages are visible on the graph in Figure 2a showing car modal shares over the last 50 years, first rising, then plateauing and subsequently falling. The evidence therefore shows that the policies and measures introduced during the same period had a positive impact on car use reduction.

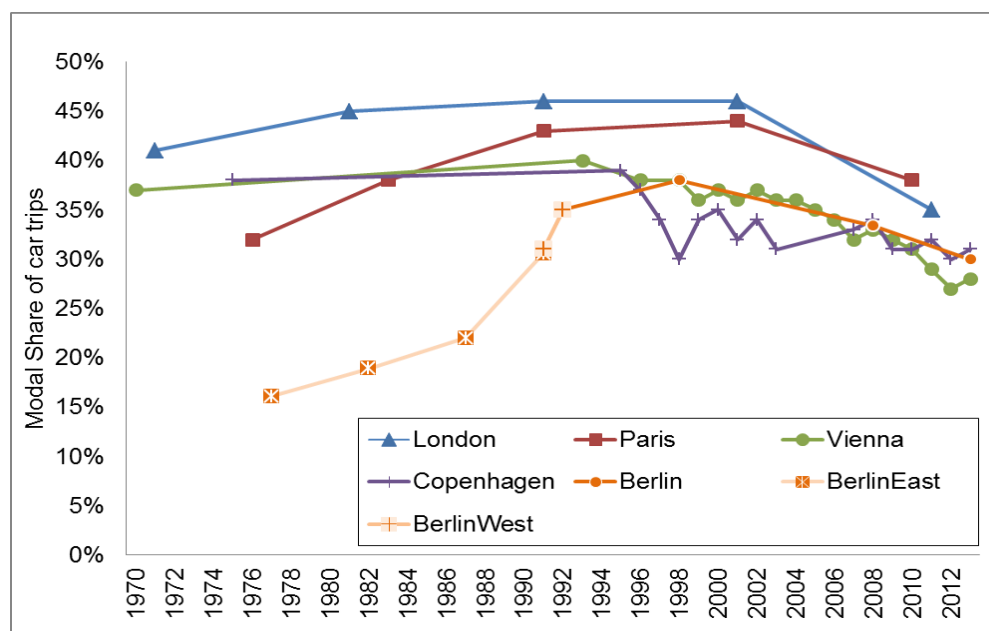


Figure 2a: Car driver modal share 1970s to 2010s

1.2 Objective

This report reviews the policies and measures which may have been the most important in tackling car use in these cities, and the contexts where this has been effective.

As such it draws from the long term qualitative and quantitative research conducted in WP3 and WP4, with a particular focus on the outputs of Deliverable 4.2, including the City Reports. It also integrates the insight from WP2 and the needs of other cities which wish to advance from car-based models towards those with increased liveability and place-making. It takes diagrams from the CREATE *Project Summary and Conclusions for Cities*, Peter Jones.

Thanks to the unique approach by CREATE, we draw upon insights gained from the research of long term analysis and trends in the five cities and make cross-site comparisons underlining common experiences. It shows us that if certain packages of urban mobility measures and policies are introduced over a long period of time, there is a very high propensity for car use reduction. These are powerful, evidence-based conclusions that can be transferred to cities across Europe and beyond.

The report acts as a useful reference tool for cities aiming to reduce car modal share, to get inspiration and justification for implementing chosen measures and policies: small and large scale; as well as low cost to high cost. This means even municipalities with limited budgets can already advance towards more liveable cities introducing Stage 3 measures.

As such it appeals especially to Stage 1 and Stage 2 cities, but can also consolidate the current path of a Stage 3 city, which may have a change in administration and political priorities.

In WP2, city stakeholder needs were assessed which determined that transport planners were considered the primary target group in Stage 1 cities for these learnings, to fill gaps in capacity and knowledge. In Stage 3 cities, land-use planners were perceived to be the primary market to justify redesigning urban space as car use declines. In all cities, policy makers were seen as an important audience for which such insights were to be transmitted.

1.3 Combining measures

The CREATE research has provided insights into the correlation between the types of transport and mobility measures implemented by a city and the concurrent trends in car use. It is rarely possible to prove that a single measure is solely responsible for a particular shift in modal share across an entire city; unless that measure is of very significant scale.

Crossrail for instance, will add 10% extra capacity to the public transport network of Greater London. When fully operational in 2019, it might be possible to conclude this sudden extra capacity is indeed responsible for any subsequent modal shift seen from car to public transport.

However, most cities do not experience such gigantic increases in mobility 'overnight'. Rather it is better to draw conclusions over longer periods of cumulative combinations of measure implementation and modal shift trends. This is the added value of the CREATE research.

Behind the vehicle-based, mode-based and place making (C, M and P) policy types are the specific measures introduced in specific parts of a city. At any point in time, a city will be implementing measures relating to all 3 policy-types. This is because cities do not simply cease implementing Stage 1 measures, when progressing to Stage 2 for instance. Cities will implement a mix of measures emanating from a blend of policies as decision makers and funding sources allow such progress to be made. This is represented in Figure 2b below.

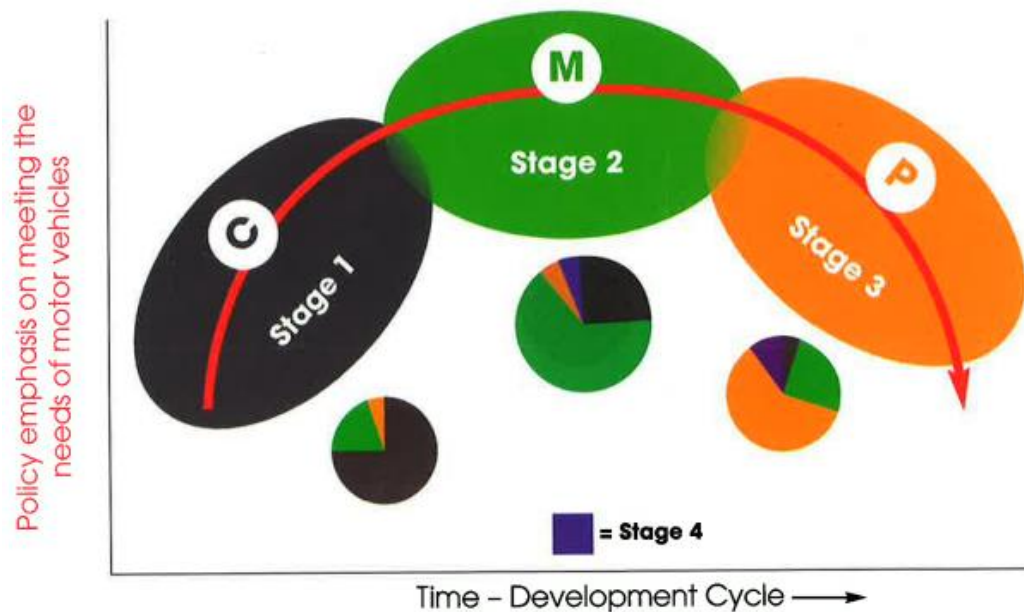


Figure 2b: Blending of policies²

The blending of policies is represented by the pie charts in Figure 3. Over the CREATE transport evolution period, the balance of C, M and P-Type policies has radically changed from vehicle-based policies to mode and place-based policies. Coupled with external factors, this has produced decline in car use.

The ‘measure mix’ refers to the specific measures introduced across a city to implement the 3 policy types: combining measures to increase the efficiency of transport networks (for example enhanced traffic control measures to combat congestion) to measures designed to provide a more attractive alternative to car use (for example, in-street public transport or cycle priority measures), to place making measures (for example reducing street capacity to provide more attractive streetscapes for local communities and visitors).

Where a city has a majority of policies emphasising a particular characteristic, it will be this stage at which the city is formally classified.

1.4 Types of measures

Measures can be divided into four general types.

Physical measures – the infrastructure measures implemented (for example road construction, street place making, urban rail systems, in-street public transport and cycle networks, multi-modal interchanges etc.).

Control measures – these measures manage the flows of vehicles and people on the transport network (for example urban traffic control systems, systems for public transport management and operations, enforcement systems, parking management).

² “CREATE Project Summary and Conclusions for Cities. Urban Mobility: Preparing for the future, learning from the past” Peter Jones et al.

Pricing measures – these measures seek to influence travel behaviour through the pricing mechanism (for example congestion charging, public transport fare regimes, parking pricing, price incentives etc.).

Information-based measures – these measures provide information to travellers (for better informed travel choices) and to operators (to ensure smoother transport system management). During the CREATE evolution, the measures in this category developed radically with the Internet, from static timetables and road signing to real time multi-modal applications for smart phone technology.

In the context of reducing car use, the CREATE transport evolution has seen the emergence of measures which target the same objective, but in two different ways.

Push measures - The objective is to force mobility behaviour away from car use by making it less convenient or more expensive (for example through traffic restricted areas, raising parking fees and reducing capacity).

Pull measures - The objective is to provide new and/or better quality mobility options that will attract them away from car use (for example new bus or tram services, mobility rental schemes and cycling infrastructure) combined with awareness-raising strategies to influence opinion.

The CREATE Stage 3 cities have all employed a differing mixture of push and pull measures from which other cities can learn.

Figure 1c shows the introduction of a push measure in London where car use has been made less convenient by reallocating road space to pedestrians and cyclists.



• *Figure 2c: Comparison of Stage 1 with a Stage 3 measure³*

The top photo is of the Aldgate gyratory in London which was introduced in the 1960s to enhance road capacity to accommodate more motor vehicles. At this point the city overall was a car-oriented city (Stage 1). The bottom image shows the transformation into a public space

³ CREATE Project Summary and Conclusions for Cities. Urban Mobility: Preparing for the future, learning from the past" Peter Jones et al.

and a new community area. With strong policy objectives to this effect, the inner urban area is now classified as a city of places (Stage 3).

1.5 External factors

It must be noted that a city's policies and subsequent measures implemented will not be the only factors that lead to an impact on car use and congestion. There will be external factors that should be considered.

The performance of the economy is one obvious factor as disposable incomes have a bearing on transport choice. The same can be said about fluctuating oil prices and the impact on the cost of running a car.

More recently, changes to employment patterns are also a influence, whereby flexible working and part time contracts may change the demand for mobility or indeed the time of day when travel is required. Equally, companies opening new employment sites may chose locations which are naturally geared towards public transport access rather than private car. High density and mixed use developments can also reduce the need to travel, namely where accommodation and workplaces are all at walking distance.

2.Measure mixing in the five CREATE cities

CREATE shows us that the best way in which to realise a reduction in car use in a city is through a combination of measures which provide good alternatives (pull) and those which actively discourage (push). This is best done within a target-based and vision-based Sustainable Urban Mobility Plan.

On the whole, Berlin, Copenhagen and Paris have tended to give greater priority to pull measures relative to London and Vienna which have employed marginally more push measures.

Cities seeking to advance to Stage 3 can draw on this convincing evidence and proceed in confidence that flexible approaches can all lead to reduction in car modal share, whilst remaining sensitive to local political priorities.

2.1 Berlin

Figure 3 shows the change in on car trip modal share during the last 40 years. There is an upwards trend until about 1999, after which it started falling steadily and relatively sharply. When considering the measures implemented during the same period, a conclusion can be drawn on their effectiveness in stemming demand for car use. Other external factors are also indicated which may have had an impact.

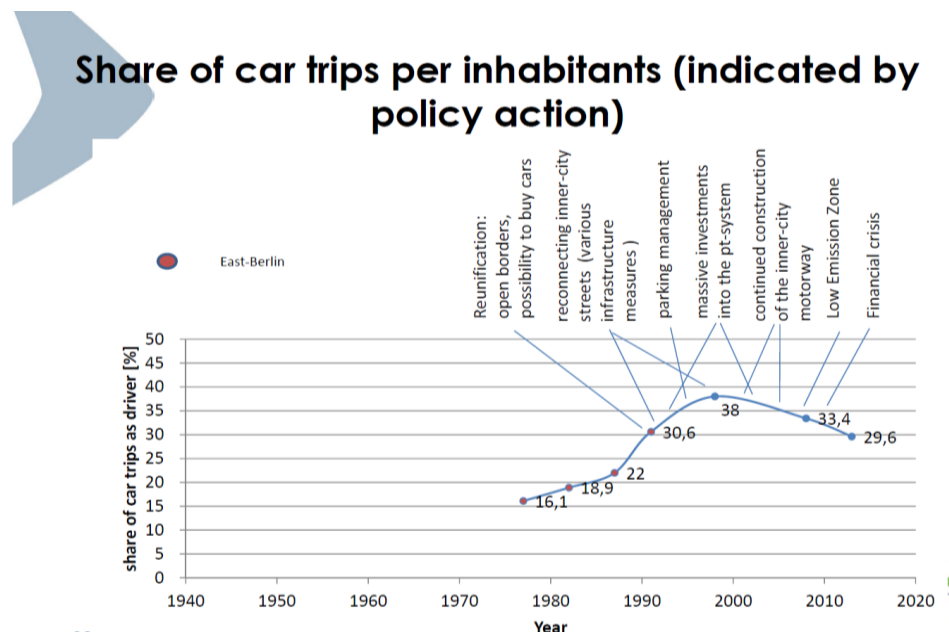


Figure 3: Share of car trips in Berlin

One large contributor was the completion of large scale public transport re-connection projects such as the S-Bahn. Between 1991 and 2012 the length of the PT network increased from around 1,750km to almost 1,900km. In addition, a sophisticated traffic light management system giving bus priority resulted in a significant improvement to punctuality of trams and buses making public transport an attractive alternative. Whilst car use was still increasing (due in part to reunification and the new opportunities for purchasing vehicles in East Berlin).

Speed reduction and traffic calming measures were introduced in West Berlin during the 1980s in order to address residents' concerns about road safety and noise pollution. It was

progressively extended under the leadership of the Transport Administration throughout the 1990s as a preferred mitigation measure. This policy was continued and intensified after 2003. Traffic is limited to a 30kmph speed limit in nearly all side-streets in Berlin (over 70% of the road network). There are also mandatory speed limitations of 30kmph on some 60 sections of main roads between 10pm and 6am this aims to tackle noise pollution as is also known as Tempo 30. This is a low cost Stage 3 measure.

The Low Emission Zone further adds to these push measures, although research shows that whilst this has not had a noticeable impact on traffic flow, it has accelerated the transition towards cleaner vehicles by car owners.

Between 1999 and 2006 other pull measures were introduced which further support the shift away from car use, namely: Bus investment; bike parking; and a common tariff for regional public transportation.

From 1997 nearly all bus lanes were allowed to be used by cyclists and the transport of bicycles on trains became possible. This was another low cost pull measure. Little by little cycling has become an urban trend and the share of modal split increased from 10% to 13% by 2013.

In 2013 a Cycling Strategy was enacted, which included a programme for expanding cycling facilities including 15 to 20km of cycle paths, 3000 bicycle parking spaces at railway stations and re-dedication of small roads as cycle streets.

In 1997 the laws were changed to allow bikes to use bus lanes and to be brought onto trains and S-Bahn services. This is an example of low cost measures which do not focus on physical aspects, but instead enable demand for sustainable mobility through changes to rules and regulations. Some years later, the bike modal share had increased from 10% to 13%.

It was not until relatively recently that planning for walking was considered a major issue in Berlin. As part of its 2011 Strategy for Pedestrians the following indicators were introduced in order to monitor implementation of the Berlin Walking Strategy: rise in user satisfaction, decrease of accidents, accessible spaces and levels of funding. Ten pilot projects were initiated, such as “encounter zones”, where traffic speed was limited to 20kmph. The participation of children and young people was encouraged in order to get the perspective of different users of public space

The framework of the 2003 Strategic Policy Framework for Sustainable Mobility (StEP) sought ‘city-friendly mobility’, where all modes were considered in a balanced way, and where even car-based ‘C-Type’ policies were not stigmatised but seen as part of the necessary mix.

| Year | Pull measures | Year | Push measures |
|------|---|------|--|
| 1996 | Common PT tariff | 1995 | City Friendly Traffic: 30 km /h roads |
| 1999 | 8500 bike parking spaces built at S-Bahn stations | 1995 | Parking Management System in entire city |
| 1999 | Introduction of common PT tariff by VBB | 1995 | Low Emission Zone |
| 2002 | Reconstruction and modernisation of the old S-bahn network, including the reopening of the Ringbahn | | |
| 2006 | 3000 bike parking spaces built at underground, tram and bus stations | | |
| 2006 | Launch of bus investment programme – prioritisation at signalled junctions | | |
| 2012 | Free floating car share schemes | 2013 | Meeting areas initiative: 20 km/h zones |

Table 1: Key measures implemented in Berlin over time

Table 1 presents a summary of measures and their dates of realisation.

Overall Berlin appears to have achieved their reduction in car modal share through a greater proportion of pull factors, rather than push factors. This approach is a similar story to Paris, as detailed later.

It should be noted that the governance in Berlin changed significantly during the 1990s post reunification. In 1990 Berlin was declared as a City-State with the area of greater Berlin confirmed. Capital city status opened the door to additional financing and formalised cooperation between Berlin and Brandenburg State resulted in a dedicated agency for public transportation, the Verkehrsverbund Berlin-Brandenburg (VBB)

Additional federal budgets assisted the city and region. The objective to develop infrastructure for a capital city of the 21st century was strengthened in 1996 by the setting-up of a joint planning authority for the city-region. This new body set-up agencies to address specific issues such as urban commuting. One lesson to draw is that it was realised that policy had to be developed for the whole functional region and not just for Berlin city, in the context of fast rising car ownership post-unification and decentralisation.

Cities should therefore consider planning on the basis of city-regions, to unlock financing and make services more connected and combining transport and urban development functions.

2.2 Copenhagen

The 1970s and 1980s saw a political move towards mitigating the negative impact of car use, driven by demands from the inhabitants. This saw the following measures realised:

- Major traffic calming schemes were implemented to move car traffic from local streets to major streets;
- Progressive regulation of car traffic entering the city by using traffic signals to hold back cars at city border especially at rush hour, smoothing flow in city centre;
- Reallocation of road space from cars to pedestrians;
- Limiting supply of parking in city centre;
- Consistent building of cycling infrastructure.

From the 1990s, the vision was centred around a more 'liveable city' with the powerful branding of Eco Metropolis. This saw the following measures introduced:

- Major improvements of public transport with the new Metro, priority schemes and lanes for buses and a system with new frequent "A-bus" lines;
- Strategic focus on improving the image of bicycle traffic by infrastructure investments, restrictions for car traffic and focused marketing.

This policy emphasis has continued with the iconic pedestrian and cyclist Harbour Bridge recently opened, funded by the private sector, continuing the message that active travel is a priority for the city.



Figure 4: Copenhagen cycling and walking bridge

Since the 1990s, Copenhagen started implementing a network of green cycle paths decoupled from roads. Some of them utilise abandoned railways. A significant expansion of standard cycle tracks were also added to the city during that period, as shown in Figure 5, with more than 450km now in place.

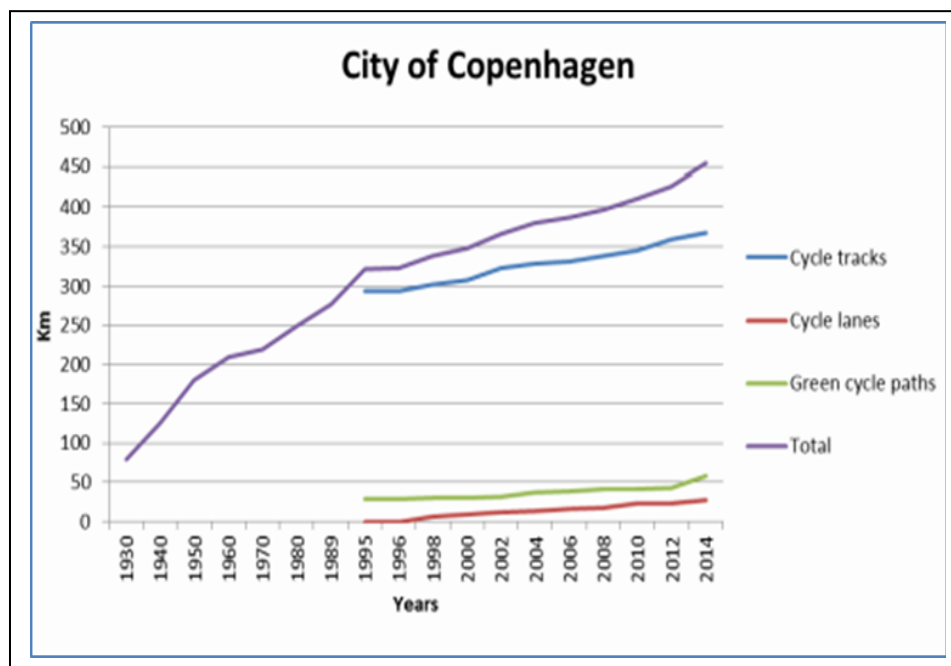


Figure 5: Expansion of cycling infrastructure in Copenhagen

The graph shows the total kilometres of cycling infrastructure (purple line) increasing fastest between 1970 and 1995, then continuing to rise since then until present day.

In addition to the new infrastructure, Copenhagen promoted this mode by implementing a variety of measures, including:

- Implementation of green wave technology for cycle traffic;

- Provision for cycles to be carried on trains, water buses, the metro and taxis;
- Consideration of additional initiatives to support cycle movement such as cycle (and walking) signs, route planners and dynamic cycle signs;
- Implementation of a bike sharing scheme.

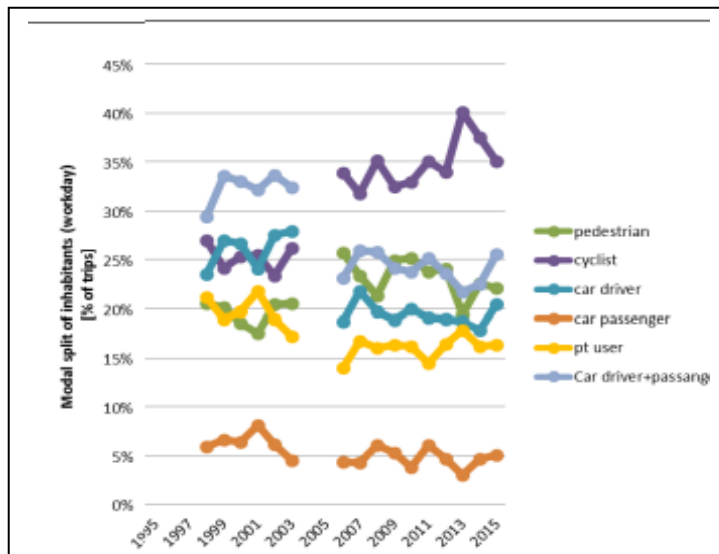


Figure 6: Modal share Copenhagen

This significant increase in cycling as a valid alternative to the car has, unsurprisingly, been met with an increase in cycling modal share as shows in Figure 6: From approximately 28% in 1993 to 40% in 2013. In the same period, car modal share decreased from 34% to 22%. It also takes place at the same time as a reduction of car driver share. These correlations are very strong and so it can be determined that these combined cycling measures were instrumental in increasing cycling modal share, shifting journeys from car use.

It is not just cycling infrastructure which has seen consistent enhancements over the years. Space for pedestrians has also seen a significant increase in prioritisation as shown in the Figure 7.

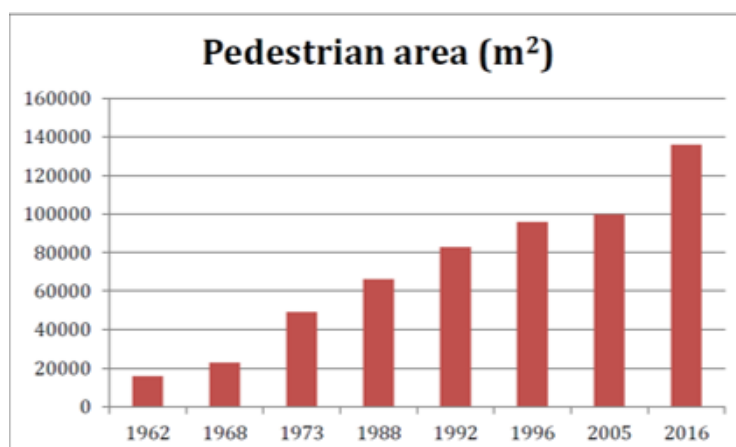


Figure 7: Growing surface area for pedestrians in Copenhagen

Car sharing has also proved to be a successful measure in reducing private car modal share. In 1998, a car sharing scheme was established in Copenhagen offered by Hertz Car Rental at the request of City of Copenhagen. A number of car sharing organisations have been since established typically as a local association such as Københavns Delebiler (Copenhagen Car Sharing), which started in 2004.

In 2005 City of Copenhagen decided that 150 parking lots in the payment zones should be reserved for car sharing. The first 85 parking lots were established in 2006 and the number has increased since then as shown in Figure 8.

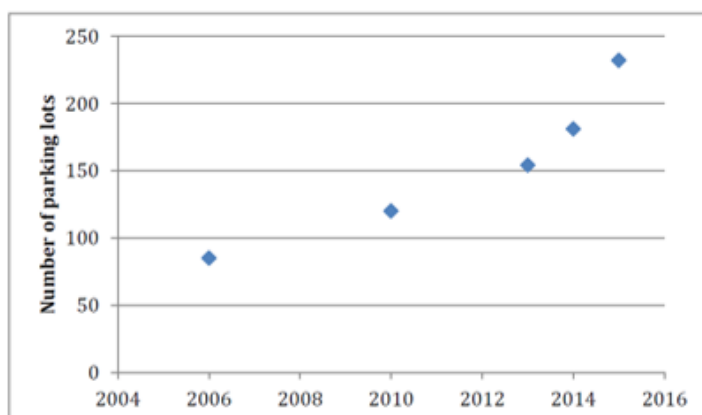


Figure 8: Number of parking lots reserved for car sharing in Copenhagen

Free-floating car sharing was introduced in Copenhagen by Car2Go in 2014 and in 2015 DriveNow was introduced, which is a company with electric free-floating car sharing.

One hugely significant pull factor in Copenhagen – in addition to the extra infrastructure - has been the delivery of support services including being able to take bikes on public transport, introducing a bike share scheme and introducing dynamic cycle signs.

Table 2 shows a summary of measures stressing the importance of a combination of push and pull to realise the vision of a liveable city.

| Year | Pull measures | Year | Push measures |
|---------|---|-------|---|
| 1974 | First bus lane | 1970s | Low Speed policy for cars, car traffic diverted to main streets |
| 1974 | Combined PT tickets | | |
| 1976-80 | Bus prioritisation at signalled intersections | | |
| 1983 | Bikes permitted on trains | 1989 | Council agrees to remove parking from Kongens Nytorv square |
| 1998 | New S-trains cycling dedicated carriages | 1990 | Paid parking |
| 1999 | Taxis obliged to accept bikes on board | | |
| 2000 | Harbour ferry buses | | |
| 2002 | Metro opens | 2005 | Car free streets network increases |
| 2008 | Bike Sharing Scheme | 2008 | Low Emission Zone |
| 2012 | Let's Go car share scheme | | |
| 2012 | First Cycle Superhighway opened | | |

Table 2: Key measures implemented in Copenhagen over time

On the whole, Copenhagen has introduced a balanced set of policies and measures with an emphasis on 'pull' rather than 'push'. This multi-faceted approach to enabling and enhancing cycling has most likely been among the decisive parameters for giving the foundations on which the city's overall sustainable transport objectives have been realised over many decades.

2.3 London

There is a familiar picture of push and pull measures in London, but with some differences to the other Stage 3 cities. London's large investment in public transport started later than elsewhere due in part to a lack of a decentralised body to initiate it. However, the newly created Greater London Authority and the Mayor of London were elected in 2000, following which there was a rapid and significant programme of investment in public transport. Initially the focus was on the bus network, followed by tram, train and underground.

Good practice suggests that cities should ensure adequate alternatives to the private car are in place, before introducing punitive measures to push users away from that mode. However, the congestion charge was introduced only three years after the Mayor took office. The fruits of the bus investment were not yet fully mature, yet this big bang approach of introducing one of the most radical push measures available was widely seen as a success in reducing car use in the city centre, and hence contributing to a shift to other modes.

The Congestion Charging scheme was introduced in February 2003 and has resulted in notable traffic reduction in central London. Within its first year, congestion within the charging zone area indicated 30% average reductions. In addition, traffic entering the zone during charging hours fell by 18%, whereas traffic circulating within the zone reduced by 15%.⁴



Figures 9 and 10: London Congestion Charge

It is therefore understood that the Congestion Charge was responsible for shifting people away from car use, especially in central London which saw reduction in vehicle kilometres of 23% (figures for 2000 to 2012)⁵.

This impact has been progressively eroded as measures such as the introduction of cycle and bus lanes have reallocated road space away from cars. However, this has been instrumental in increasing capacity and accommodating a rapidly increasing population to move sustainably around town. The re-election of the Mayor in June 2004 showed that such tough push measures can prove acceptable to citizens.

⁴ https://consultations.tfl.gov.uk/roads/cc-changes-march-2014/user_uploads/cc-impact-assessment.pdf

⁵ https://consultations.tfl.gov.uk/roads/cc-changes-march-2014/user_uploads/cc-impact-assessment.pdf

The charge has been progressively increased from £5 per weekday in 2003 to £11.50 today. As a result it has become an ever increasing source of funding for the transport authority TfL which received £160 million net income for the year 2016-17, as per Figure 11.

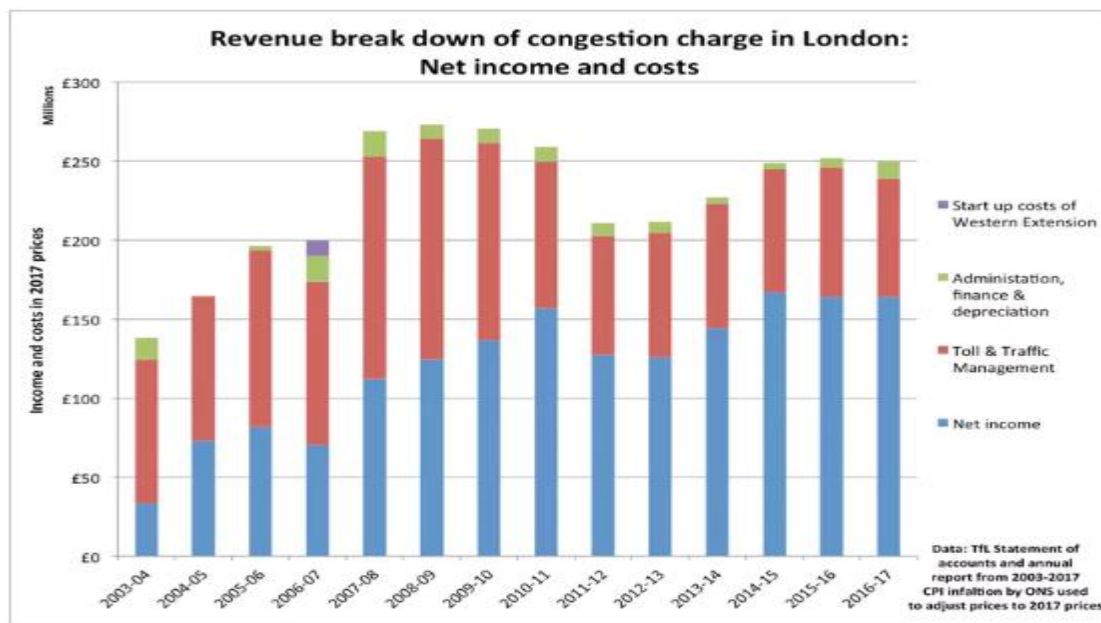


Figure 11: Income from London Congestion Charge

In its first year greenhouse gas emissions reduced by 16% and there was a 37% increase in the number of passengers entering the charge zone by bus services.

Also in 2003, the Air Quality Strategy was published, and since then, successive Mayors have increased priority for transport measures to tackle air quality, with the current focus on 'Healthy Streets' and liveability.

The Ultra-Low Emission Zone, due in 2019, will require cars to meet Euro 6 standard for diesel engines and Euro 4 standard for petrol engines. Non-compliant vehicles will still be able to enter the zone but will be required to pay a daily charge of £12.50 on top of the Congestion Charge. It is therefore possible that this will have a direct impact on car use.



Demand for alternatives to conventionally fuelled vehicles can also be stimulated through integration with spatial planning. In London, the regional spatial plan provides guidance to developers to include specific numbers of charging points in off street parking, to help foster zero emissions mobility. This can offer a minimal or zero cost to the city, with developers bearing the cost.

The Greater London Authority has powers over transport, planning and economic development and so can make decisions on transport and spatial development in an integrated and mutually supporting way: allowing targets that span different policy areas to be tackled strategically.

Table 3 shows a variety of push and pull measures introduced by successive Mayors from opposing parties, but which on the whole, have followed a common vision. It shows some of the strongest collection of push measures from the CREATE cities.

| Year | Pull measures | Year | Push measures |
|------|---|-------|---|
| 1983 | Zonal based travel cards for PT | 1969 | Inner London Parking Area extended and meter charges raised |
| 1998 | Trafalgar Square part-pedestrianised | | |
| 2000 | Croydon Tram Link | | |
| 2001 | Significant investment in bus network commences, including prioritisation | 2001 | 20 mph zones started being introduced |
| 2003 | Oyster Card introduced – smart contactless PT card | 2003 | Congestion Charge introduced |
| 2006 | Legible London programme to improve pedestrian wayfinding | 2007 | Congestion Charge Zone extended |
| 2010 | First two Cycle Superhighways opened | 2008 | Low Emission Zone |
| 2011 | London Underground upgrade programme commences | 2010s | Reallocation of road space from private car to PT, walking and cycling. |
| 2018 | Crossrail due to open delivering 10% extra PT capacity for London | 2019 | Ultra-Low Emission Zone due |
| | | 2020 | Oxford Street pedestrianisation due |

Table 3: Key measures implemented in London over time

The combined results of these measures has been impressive.

Between 2000 and 2011, there was an 11% shift in modal share from car to other modes in London, namely public transport, walking and cycling. This is recognised as a very significant achievement. In 2000, 43% of trips were made by car, compared to 32% in 2011. Bus mode share alone during this period increased from 15% to 21% indicating the early investment by the Mayor was very successful in pulling citizens onto this alternative.

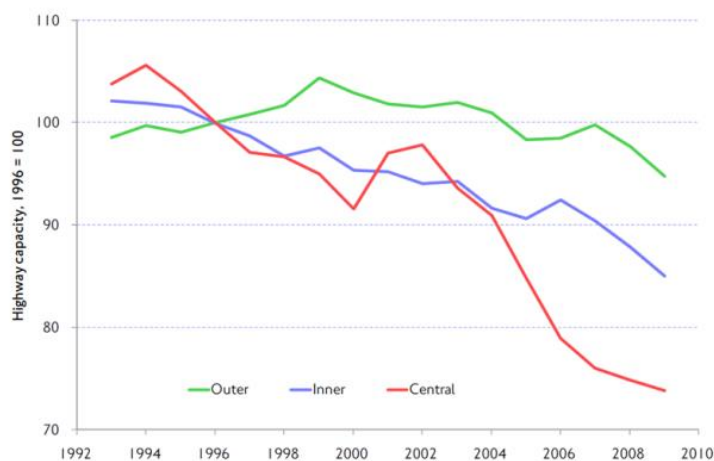


Figure 12: Inferred change in available road network capacity in Greater London

The red line in Figure 12 shows that during the same period, highway capacity in inner London was reduced significantly, whereby space was reallocated to other modes. This has been a technique employed in other Stage 3 cities. Such reallocation, in a joined up way, actually increases the capacity of the infrastructure overall.

One area currently under consideration to help fund public transport infrastructure in future is Land Value Capture. Such mechanisms seek to capture a proportion of land value gains to fund the transport infrastructure which causes them.

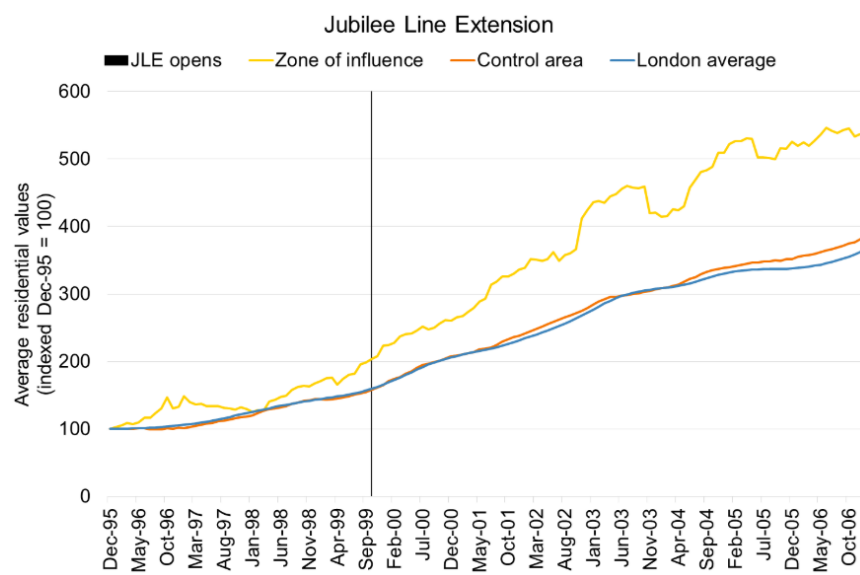


Figure 13: Land Value Capture potential⁶

Whilst this has not yet been employed, it is important to highlight its potential as per the example in Figure 13. The yellow line shows the average residential value before and after the opening of the Jubilee Line underground extension in September 1999. It shows that both before but especially after the launch, property values increased very significantly compared to the London average and the control area. Tapping into this source could offer a new source of investment for cities everywhere.

Figure 14 is one of many examples in London of reallocating road space from private vehicles to walking and cycling.

⁶ http://sites.v3.savills-vx.com/183/_images/UK%20news/jubilee-line-extension.png



Figure 14: Reallocation of road space to cycling and pedestrians in London

What is more interesting is the way in which the costs for the 2012 scheme in Camden, north London, were justified. The municipality used the Health Economic Assessment Tool (HEAT) and the Sickness Absence Reduction Tool (SART) as part of the appraisal process.

HEAT measures the monetised value of reduced mortality of users of new walking and cycling infrastructure. SART applies the well-founded research proving that physically active employees take 25% fewer absence days, hence it is possible to measure relative increase in business output. When combined, benefit value derived from HEAT and SART equated to £441,000 which almost entirely covered the estimated scheme cost of £475,000. This proved to be a very convincing case for investment and was approved. Transport for London advocates the use of these tools in such appraisals.

During the period from 2000 to 2012, the number of daily journeys made by bicycle in Greater London doubled to 580,000. This has freed up capacity on public transport, helping to attract car users to make the shift.

Successive mayors have invested in public transport, walking and cycling alternatives to continue to pull citizens away from private transport, whilst introducing numerous push measures like the congestion charge, parking management and reallocating road space. The main drivers in the SUMP have been to enhance quality of life, improve safety, improve air quality and support economic and population growth.

Taken together, this has proven to be a good example of push and pull measures working in tandem to affect positive modal shift, with a relatively stronger combination of push measures than Berlin, Copenhagen and Paris.

2.4 Paris

In Paris, the foundations for a shift away from car use were made in the late 1970s, 1980s and 1990s which saw a significant expansion in the public transport network. This was made possible in part thanks to the investment funds generated by the Versement Transport (a local tax levied on companies).

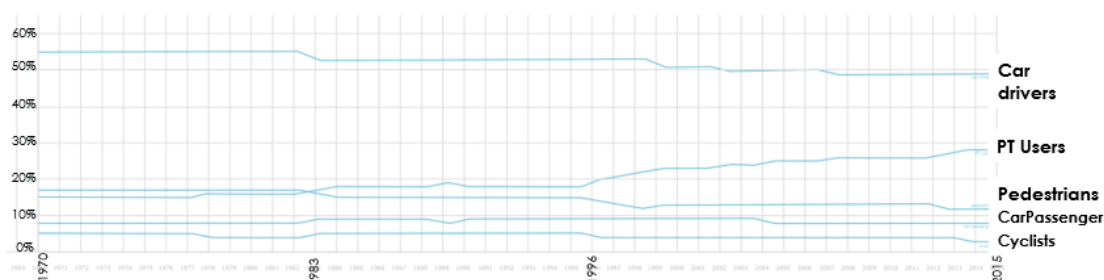


Figure 15: Change in Paris modal share

Figure 15 shows that the shift towards public transport really started in earnest from 1996 onwards, lagging slightly behind when the significant investment was delivered. Car driver modal share however has declined slowly but steadily since during the whole period.

Key measures implemented in the city-region are shown in Table 4.

| Year | Pull measures | Year | Push measures |
|-------------|--|-------------|--|
| 1977 | First RER line (A) opened | 1971 | Establishment of the Versement Transport Tax which eventually allowed STIF to strengthen its public transport capacity and efficiency in the region. |
| 1992 – 2014 | Opening of urban tramway lines – T1 (plus extensions), T2, T3 (plus extension), T4, T5, T6, T7 and T8. | | |
| 1998-2013 | Metro line implementation or extensions of lines 4, 8, 12, 13 and 14. | 1995 – 2005 | Implemented speed reductions in 31 neighbourhoods in Paris. Reduced the allocation of road space to car traffic |
| 2000s | Implementation of the Quartiers Verts policy initiative | | |
| 2001 | Expansion of 300km right-of-way bus lanes | 2003 – 2011 | Practical disappearance of free on-street parking |
| 2005 | Introduction of night bus services | | |
| 2007 | Launch of Velib' cycle sharing scheme | 2015 | Introduction of a environmental zone ('Zone à Circulation Restreinte') |
| 2009 | Introduction of Mobilien rapid transit lines | | |

Table 4: Key measures implemented in Paris over time

The Versement Transport (VT) is a local tax levied on the total gross salaries of all employees of companies of more than 9 staff members, which raises capital investment for public transport infrastructure. It was introduced in 1971 and is the largest source of funding for the regional transport authority STIF, making up 39% of operating revenue in 2014.

VT rates have steadily increased to a maximum of 2.95%, justified by the Grand Paris Express programme starting in 2010. This includes plans for 205 Km of additional metro lines in Paris and the inner suburbs to be built by 2030. This comprises metro line extensions, new automated metro lines and 72 new stations.

Most experts recognise that the VT has played an instrumental role in the shift away from the car-orientated city (Stage 1) and advancement of Stage 2 and 3 policies. Decentralised sources of investment of this kind can help make authorities more resilient to external funding pressures, and can reduce reliance on the national level.

High levels of air pollution in the 1990s in Paris led to the establishment of the 1996 LAURE law (Air Quality and the Regional Use of Energy). Organised networks of public health

professionals, urban planners, and proponents of non-motorised transport came together drawing on research from their domains of expertise. What resulted was an innovative policy response, with the LAURE law brought forward which introduced obligations and policy tools to support different sectors to deliver pollution reduction measures. In the transport domain, Mayor Tiberi advocated a push towards alternatives to car use (bike way, tramway, bus lanes) rather than traffic bans and congestion charging. Following recommendations by the Ministry of Environment at the national level, car free initiatives were introduced as well as those aimed to reduce speed limits.



Figure 16: Paris Tramway

In more recent developments, the Paris Mobility Plan, formally adopted in 2007, introduced two ambitious goals for 2030: to reduce the share of individual car use by 40%; and achieve a 20% increase in public transport. In proposing to reduce car use by prioritising alternatives such as public transport, cycling, and walking rather than through anti-car policies (e.g. congestion charging, low emission zones, etc.), it continued the stance of previous administrations: that of priorities on pull rather than push measures.

This planning document, which advocates “planning for people” provided the legal basis for further scaling up the pull measures of bus network expansion and implementing flagship projects like the Velib bike-sharing system and urban tramway expansion. It also made provision for the lighter push measures of street redesign and traffic calming.

The flagship Quartiers Verts initiative 2001-2014 (Green Districts), strategically combined pedestrianisation, expanding cycle lanes, right of way bus lanes and greening of public roads. The districts were integrated into local traffic plans in order to divert traffic towards main axes, as well as into city-wide plans to expand cycling lanes, right of way bus lanes and encourage walking.

The Quartiers Tranquilles initiative (Quiet Districts) introduced between 1995 and 2001 saw measures introduced in 31 neighbourhoods which combined the reallocation of road space for car traffic, with the reduction of speed limits. By 2014, when combined with Quartiers Verts, these accounted for 18% of the city’s territory and a third of Paris’ roads saw reductions in the speed limit to 30km/h. They were considered innovative as they simultaneously discouraged transit traffic whilst freeing up space for local place-making.

Overall, Paris has favoured a higher proportion of pull measures, compared to London and Vienna, but with equally good results. This shows a flexible approach can be taken.

2.5 Vienna

The Urban Development Plan lays down principles for urban growth in Vienna, noting that increasing population is a key driver for measure priorities. The Mobility Action Plan specifies the role of transport in achieving these goals. Since the 1990s there have been two principle measure objectives: 1) to increase public transport capacity; and 2) to reduce car use through a parking management system. This shows Vienna's integrated approach over the last 30 years or more, by providing alternatives whilst actively discouraging car use. This is illustrated in Table 5.

| Year | Pull measures | Push measures |
|------------|---|--|
| Pre 1990 | Regional bus routes integrated PT system | Speed limit 30 km/h introduced across 33km of city wide road network |
| 1990-2007 | Metro extension intensified | Extension of parking management system |
| | Transport Plan aimed for citizens to be within 500m of PT | |
| | More segregated bus lanes | |
| | Park and Ride | |
| | Cycling routes increase from 388Km to 1174km | |
| | Bike sharing and car sharing system 1997 | Road narrowing, road space reassigned to pedestrians |
| Since 2007 | Daily and Annual PT Tariffs reduced (e.g. €1 per day) | Parking Management System extended to entire city |
| | Cycling network developed further | Pedestrianisation and opening to cyclists of main Mariahilfstrasse shopping street |
| | | Shared space designed delivered to reduce car use |
| | | 20km/h zones introduced |
| | | Low Emission Zone introduced |

Table 5: Key measures implemented in Vienna over time

Table 5 indicates the successive measures introduced during different periods since 1990. It also shows that the city introduced measures to restrict car use principally only after a significant number of measures had already been delivered to provide alternatives to citizens. This has proven to be a successful approach.

The parking management system, first introduced in 1993, has become a trademark 'push' approach to car reduction. Only residents were allowed to buy a permit for long term parking, whereas non-residents were just offered short stay parking. This was introduced in the inner-centre and progressively extended towards the districts and now covers the whole city. Pricing increased and park and ride introduced. Figure 17 shows the first expansion (red) and the second (blue and yellow).

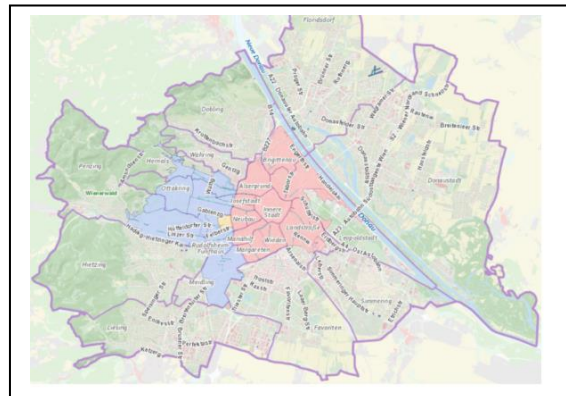


Figure 17: Vienna Parking Management Zone extension

The creation of the Mobility agency in 2010 was a first step towards growing political capacity building in support of cycling and walking. This agency is located outside the city administration. It benefits from little funding and administrative resources, but its main strength relies in its ability to mobilize a large variety of stakeholders through advocacy campaigns and flagship initiatives. It also develops specific information and communication tools, such as a cycling and a walking map, in support of these transport modes.

Public transport extensions have been coupled with overground urban design initiatives. Between 2013 and 2015, the decision was made to pedestrianize and open to cyclists the Mariahilferstrasse, a large, emblematic shopping street behind the newly redeveloped museum quarter. This project led to a negative reaction the local and the national press.

In adjacent streets, a shared space concept was developed in order to reduce car use. Traffic calming measures, including a maximum 20 km/h speed limit in directly adjacent streets and 30 km/h speed limit in other through traffic and access routes, were applied in these areas to both car drivers and public transport.



Figure 18: Shared space in Vienna

Public transport extensions were coupled with new tariff structured and fare reductions leading to the annual season ticket costing €365, or €1 per day. This acted as a powerful pull towards public transport and away from car use.

The impact of these alternatives to - and restrictions on - car use are shown in Figure 19. Car modal share has decreased dramatically from 40% in 1993 to 28% in 2014. There is an inverse relationship with the resulting shift in public transport which increased from 29% to 39% in the same period. Cycling has also increased from 3% to 7%. Future targets for decreased car use and increase alternative modes for 2030 have been set which gives a clear statement of intent where future investment priorities lie.

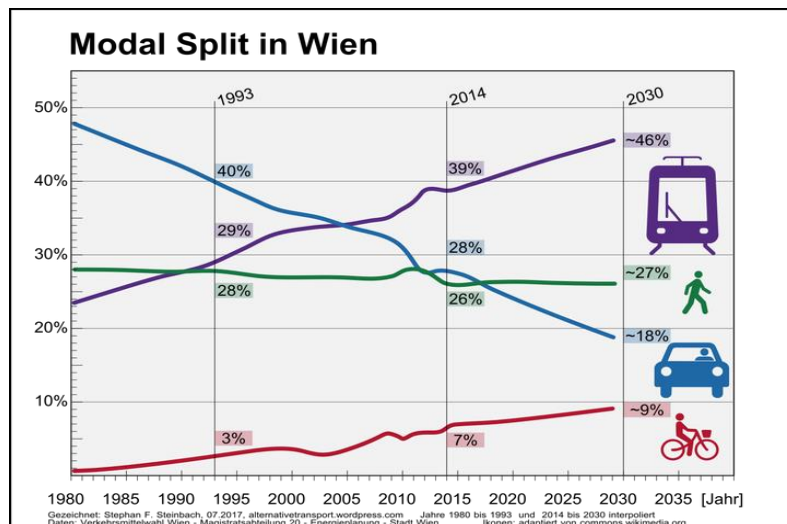


Figure 19: Vienna modal split

This therefore validates and vindicates the consistent approach taken by decision makers to prioritise investment in collective transport, active travel, shared mobility and infrastructure for moving people rather than cars; whilst discouraging car use.

It is a message that should be communicated to planners and policy makers in cities across Europe, to drive support behind SUMPs and unlock funding for measure delivery.

3. Conclusions

We have seen that all five Stage 3 cities have implemented a mixture of push and pull measures in their advancement to more liveable and sustainable urban spaces. In many cases a similar process is visible: that investment in alternatives (the pull) precedes by some years the onset of the push measures.

This is of course logical and could explain why each of the five CREATE cities have subsequently enjoyed a successful reduction in car use.

What is also interesting to see is the different proportions of push and pull measures a city chooses. Berlin, Copenhagen and Paris have followed a path with a relatively greater emphasis on pull rather than push measures; compared to Vienna and London where push measures feature more prominently. These differing proportions are determined by political priorities, demands from the inhabitants and stakeholders, as well as funding and financing streams.

Whilst cities have chosen different combinations of measures, on the whole the core push and pull mechanisms are often the same. This suggests that, in order for a city to successfully reduce car use, the following measures and policies should form the foundations, which can be supported further by a variety of those cited above.

| Core pull measures | Core push measures |
|-----------------------------|----------------------------|
| Public transport investment | Parking management |
| Cycling investment | Reallocation of road space |
| Enabling regulatory changes | Reduce speed limits |

Table 6: Core measures found in cities that successfully reduce car use

External factors clearly influence modal share of a city such as disposable income or recessions, but to see the same trends in each of the five cities shows that the measures and policies used are certainly responsible for significant amounts of the modal shift realised.

Accumulation of policy resources & capacities at regional and/or urban levels

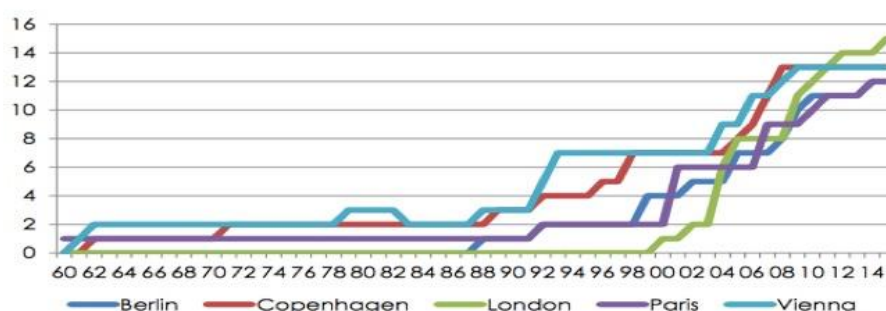


Figure 20: Implementation of Stage 2 and 3 policies and measures in CREATE Cities.

Figure 20 shows the significant increase in implementation of Stage 2 and Stage 3 measures in the five CREATE cities in the 1990s and onwards until the late 2000s.

This is further evidence of the correlation between cities that make strategic efforts to reduce car use (via push and pull measures and policies) and the resulting shift in modal share.

We have seen that some measures are of sufficient scale to have a direct impact on car use. The London congestion charge for instance saw a 30% reduction in congestion with 18% less traffic entering the zone during charging hours. But on the whole it is the mix of measures which a city chooses which makes the long term impact.

What each of the cities have shown is that reallocating road space from car to public transport, cycling and walking – whilst investing in public transport – is an effective means of freeing up capacity in the network to allow populations to increase and move freely, without having a negative impact on average journey times or the environment.