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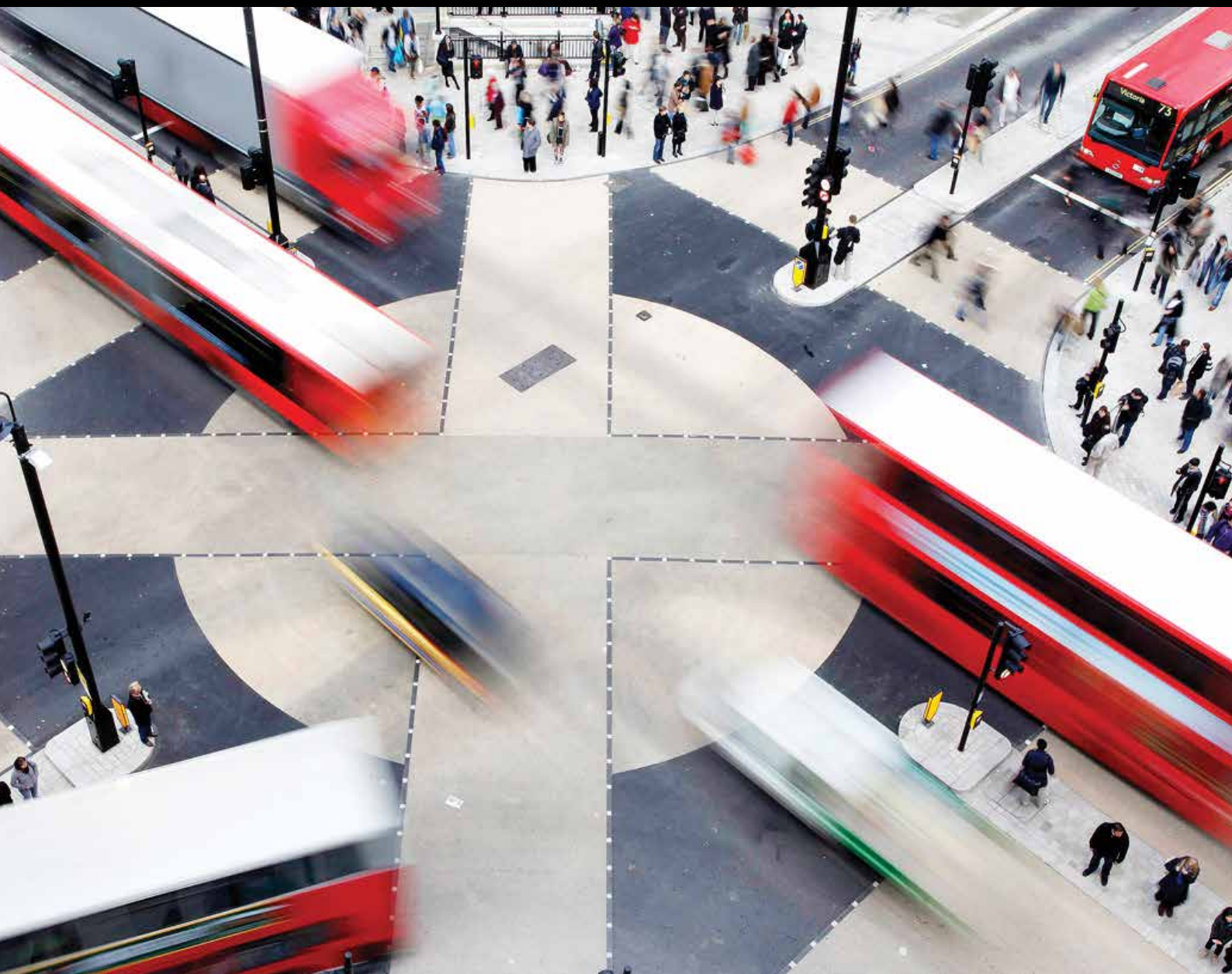
Towards New Urban Mobility

The case of London and Berlin



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Cover: Oxford Circus redesigned with diagonal crossings to improve pedestrian mobility across this busy intersection. Photography: Stefan Wermuth/Reuters

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Executive Summary

The report 'Towards New Urban Mobility: The case of London and Berlin' provides insight into how urban transport policy can better leverage new and emerging mobility choices in cities. It was prepared by LSE Cities at the London School of Economics and Political Science and the Innovation Centre for Mobility and Societal Change (InnoZ), and supported by the German Federal Ministry for Transport, Building and Urban Development and Deutsche Bank's Alfred Herrhausen Society.

Changes in urban mobility no longer follow traditional patterns of motorisation and policy makers need to embrace an increasing number of alternatives, including cycling and walking as main modes of travel, bike and car sharing, multimodal travel options and electric vehicles. Smartphone applications now support people's travel decisions as they move through the city, opening up possibilities for smarter mobility services that respond flexibly to user needs.

Drawing on the LSE Cities/InnoZ household survey of 1,000 residents each in Berlin and London, this report investigates how people's attitudes towards transport modes, technology and travel frames their willingness to adopt new and more sustainable forms of transport. The New Urban Mobility report recognises the need to complement infrastructure-oriented transport policy with softer, targeted interventions aimed at changing mobility practices of diverse groups of users. This report argues it is the combination of understanding user behaviour and using transport policy to target specific groups of users that will bring about change towards more sustainable travel.

The key trends promoting new urban mobility are:

Urban change – denser, mixed use cities and a greater interest in urban living have lowered car dependency and increased the number of residents benefiting from greater accessibility.

New alternatives to the automobile – car use and ownership have levelled off in most cities with advanced economies as public transport, pedestrian and cycling infrastructure is upgraded.

Digital technologies and transport innovations – the mobile internet and smartphones have opened up new opportunities for accessing the city. The digitalisation of consumption is encouraging access-based services over more traditional ownership models, opening up hybrid forms of public transport, taxi services and shared car use.

As transport departments continue to overestimate car traffic growth in countries like the US and the UK, this report suggests that understanding future mobility trends requires knowledge of what attitudes drive demand for different urban transport modes. The report investigates how attitudes alter opportunities in travel for today's urban transport users and how they open up opportunities for transport policies to sustain and encourage alternative forms of travel.

Study objectives and design

The principal objective of this study is to contribute to a stronger understanding of attitudes and behaviour of urban residents in relation to daily travel, and to use this knowledge to assess the potential for behavioural change and to identify more targeted policy intervention. It focuses on mobility attitudes and behaviour in the context of new and emerging urban transport opportunities, such as those related to smartphone travel applications, bike and car sharing, electric vehicles, and increasing support for urban walking and cycling.

Survey questions were aimed at understanding how subjective orientations affect the range of transport decisions made by residents. Capturing particular attitudes towards technology provides important insights into how to best guide behavioural change, while an understanding of residential preferences and geographic context offers perspectives on how attitudes to alternatives are reinforced by housing type and location. The cross-city comparison recognises how travel attitudes and behaviour differ from place to place, and how local mobility cultures shape attitudes towards alternative forms of transport. The survey provides a comprehensive overview of current user attitudes towards transport from diverse backgrounds. The findings are relevant for more effective urban transport policy aimed at encouraging sustainable travel by involving a wider section of urban residents.

New Urban Mobility in Berlin and London

Berlin and London share considerable shifts away from traditional patterns of urban mobility. They are dynamic cities, experiencing extensive socio-economic pressures with high levels of national and international in-migration and related processes of inner-city gentrification. Both cities have forward-thinking city governments that have implemented progressive land-use and transport planning policies through investing heavily in public transport, walking, cycling and the public realm. Furthermore, both cities have thriving tech industries and are using this economic specialisation to foster innovation in

electric vehicles, car sharing schemes, smart cards and mobile travel apps.

The combination of these shared factors means London and Berlin can be considered to be 'ahead of the curve' in terms of changing travel patterns. Both cities are therefore interesting research exemplars for identifying new travel behaviours and lifestyle dynamics, and changing patterns in relation to car ownership and information and communications technology (ICT) innovation.

Despite having much in common, there are also clear differences between the two cities in urban form, policies and histories. The contrasts between Berlin and London also extend to mobility and transport patterns and can be used to identify in which areas each city has been relatively successful or had the greatest problems, and to see where best practices can be shared between them. For instance, Berlin's long existing culture of cycling has shaped comprehensive cycling plans, while London has made significant advances in areas such as congestion charging.

The survey highlights common patterns and trends across Berlin and London with the following key findings:

Travel behaviour and use of alternative modes – The choice of transport modes in both cities correspond to respondents' preferences, indicating the cities' capacities to accommodate a wide range of travel demands. Cycling in Berlin is more popular than in London, which suggests potential for increased uptake if London's cycling conditions can be improved.

Car ownership and car sharing – Higher costs, adequate alternatives and environmental concerns are cited as the top reasons for not owning a car. Car sharing is increasing but its overall future relevance is difficult to predict at this point.

ICT and travel behaviour – Travel applications are used almost daily by one in four respondents who own smartphones. The use of ICT may be an extremely effective channel in opening up alternative modal choice as smartphone penetration increases.

Residential preferences – Residential preferences among respondents are diverse but reflect current trends towards urban living. Accessibility and travel opportunities are strongly influenced by residential location, and an understanding of residential patterns and preferences appears essential for understanding travel behaviour.

Mobility attitude groups

Attitudes towards travel, the environment, technology use and residential preferences were used to identify mobility attitude groups. Attitudes and values are key factors in the choice of transport modes since they reflect group specific needs, constraints and preferences in travel. This study identified six mobility attitude groups – similar in each city – which can be characterised as follows:

Traditional car-oriented (1) – This group rates driving highly. Digital technology is not valued and alternative modes are rejected as impractical or uncomfortable. Further characteristics:
- Medium to higher ages and medium to higher incomes
- Highest car and home ownership rate
- Car is main mode with highest annual vehicle kilometres
- Tend to live on the outskirts of cities
- Not amenable to new travel modes and transport services (electric car, travel apps, smart cards)

Pragmatic transit sceptics (2) – While this group rates driving highly, it expresses diverse attitudes towards the use of other modes. Technology is disliked and travel habits tend to reflect a pragmatic orientation emphasising convenience and individual travel. Further characteristics:
- Higher ages and lower incomes
- High car ownership rate
- Car and public transport are main modes
- Dispersed throughout the urban area
- Modestly amenable to using electric cars; not amenable to other services

Green travel oriented (3) – This group is environmentally conscious and prefers modes of transport that are understood to be more sustainable. While this may include innovative use of alternatives, technology is not widely appreciated. Further characteristics:
- Medium to higher ages and lower incomes
- Low car ownership rate
- Low car use, higher share of walking
- Located more centrally or close to rail stations
- Responsive to social norms in travel choice, but not amenable to electric cars or other travel services

Pragmatic transit-oriented (4) – This group rates various aspects of public transport positively, but not necessarily for environmental reasons. There is some modest dislike of digital technology. Further characteristics:
- Medium ages and lower to medium incomes
- Low car ownership rate
- Low car use and highest use of public transport
- Centrally located
- Modestly amenable to using travel apps

Technology focused individualists (5) – This group values autonomy highly, and enjoy driving, cycling and using digital technology to reinforce independence. Further characteristics:
- Younger with higher incomes
- Higher car ownership rate
- Car and public transport main modes, cycling in Berlin
- Distributed across urban area
- Not responsive to social norms, but amenable to using electric cars and digital travel services

Innovative access-oriented (6) – This group is well aware of transport alternatives and use digital technology to support innovative travel choices. They have a strong desire to live centrally. Further characteristics:
- Younger with higher incomes
- Lower car ownership rate
- Public transport as main mode as well as car and cycling
- Located in central and accessible locations
- Strongly amenable to new travel modes and services, strong response to social norms

Policy implications

This report argues that policy interventions sensitive to group attitudes are more likely to result in behavioural change towards transport alternatives. This includes understanding which transport alternatives are more acceptable to each group and how best to target communication.

Traditional car-oriented (1) – The environmental impact of mobility choices of this group should be addressed through fiscal policy mechanisms (e.g. congestion charging, parking restrictions) and mitigated by encouraging the use of low emission vehicles. As their more dispersed and suburban residential location makes physical provision of alternatives more difficult, extra charges or banning high emission vehicles in city centres may be necessary. A weaker intervention would be to provide guidance on eco-driving.

Pragmatic transit sceptics (2) – Policy focusing on this group should encourage the reduction of car use. The pragmatic orientation suggests allowing users to temporarily test alternative modes (electric cars, car sharing, public transport) for free may be the most effective way to make this group experience low emission travel modes as feasible and convenient. These interventions will likely be successful in combination with fiscal policy instruments (e.g. congestion charging).

Green travel oriented (3) – The policy goal for this group is to affirm and further expand the uptake of walking, cycling and public transport. The promotion of alternative mobility services may enable them to even better satisfy their needs and prevent them from switching to cars when personal circumstances change (e.g. relocation, children). Information that is readily available in these situations will help this group maintain travel that is consistent with their environmental awareness.

Pragmatic transit-oriented (4) – Affirming and further encouraging public transport use will support the travel decisions of this group. In addition, promoting more cycling and alternative transport services such as car sharing (when needed) may have a long-term impact, even if life circumstances change. Care should be taken that public transport and cycling remain affordable and convenient to use.

Technology focused individualists (5) – Switching from driving to low emission mobility – car sharing, electric car, cycling – should be the policy priority for this group. As this group values personal freedom, autonomy and flexibility in travel, mode switching may be best achieved through programmes that allow this group to test alternatives and discover smart and creative aspects of travelling while also enjoying health and fitness benefits. High smartphone ownership and amenability to digital technology offers a promising channel to encourage alternative forms of travel.

Innovative access-oriented (6) – Further uptake of alternative modes of travel and reducing car ownership should be encouraged. As this group is open to experiment with new transport modes and services, policy should ensure this group is kept informed about new travel options. The extensive use of mobile technology and willingness to access digital services suggests this as a channel for communicative policy. Electric cars may be an effective alternative if personal circumstances make more sustainable mode choices no longer viable.

This study highlights the diverse preferences, needs and constraints that are specific to different mobility attitude groups (see page 40). Blanket transport policy targeting all of these groups in the same way may be less effective in achieving behavioural change than a more tailored approach. Policies to reduce conventional car use in cities will continue to rely on a range of different parallel strategies: 'pull-policies' such as making alternative modes more attractive, encouraging shared mobility, and supporting a shift to electric vehicles as well as 'push-policies' such as road pricing, parking fees and other restrictive measures. However, a greater consideration of mobility attitude groups and where they live can help in identifying a more effective mix of policy interventions. This may then support further guiding the shift towards new urban mobility by moving members of each attitudinal group towards more sustainable transport modes.

New urban mobility

Sharing scarce road space between trucks, cars, trams, cyclists and pedestrians illustrates Berlin's effort to more fairly allocate space for alternative forms of transport.

Photography: Marcus Bredt

1. Introduction

Urban mobility in most cities of the developed world is changing. And, more importantly, these changes are no longer associated with the continuation of past linear trends such as the substantial increase in motorisation seen in the second half of the 20th century. Instead, cities are increasingly witnessing the impact of more disruptive change, whether as a result of technological innovation, socio-economic change or new policy interventions. The considerable and unexpected growth in urban cycling; the increasing relevance of car and bike sharing; multimodal travel assisted by smartphone travel applications; and the re-discovery of urban walking are not only the shared experiences for many cities, they have become a central focus of urban transport policy in cities around the world.

The principal objective of this study is to contribute to a better understanding of attitudes and behaviours of urban residents in relation to daily travel, and to use this knowledge to assess the potential for behavioural change and to identify more targeted policy intervention. The evidence presented in this report is based on an in-depth household survey of 2,000 residents, almost evenly divided between the Berlin and London metropolitan region. It focuses on mobility attitudes and behaviour in the context of new and emerging urban transport opportunities, such as those related to smartphone travel applications, bike and car sharing, electric vehicles and increasing support for urban cycling and walking.

1.1. Contemporary changes in urban travel

In recent years, and particularly over the past decade, significant change in relation to urban travel, lifestyles and the spatial structure of cities in developed countries has become apparent. In the 20th century, urban development was overwhelmingly defined by the rise of the automobile and spatial dispersion. In the UK the total vehicle miles travelled by car increased fivefold between 1960 and 2000, while public transport use fell significantly. As populations left for the suburbs and urban industrial jobs vanished, inner cities experienced long-term decline: in Inner London, for example, the population fell in every decade from the 1930s to the 1980s. Similar patterns of suburban dispersion and increased car use occurred across the cities of Western Europe and North America.

Yet these seemingly unstoppable trends of urban dispersion and automobile dependence have been increasingly disrupted over the last few decades. After experiencing widespread population loss in the second half of the 20th century, many inner cities have staged a revival, attracting residents and businesses back to city centres. Planning policy has changed towards compact city ideals of densification and mixed-use, with these policies supporting inner-city revival.

Complementing the evolution of urban form, there have also been significant changes in how urban populations travel. Renewed investment in public transport has reversed the decline in passenger levels, with expanding urban rail, light-rail and bus networks. New technology is transforming the customer experience of public transport through route finding, real-time passenger information and ticketing accessible through mobile devices. Furthermore, technological changes are enabling new forms of urban travel to emerge through the sharing of transport services and advances in more efficient engine technologies. Finally, a renewed focus on health, wellbeing and quality of life in cities means we are rediscovering the benefits of traditional active travel modes such as walking and cycling.

This report refers to these varied transportation trends and innovations as "new urban mobility". Together they have the potential to transform urban travel and help tackle the most pressing challenges of urban transport planning: reducing greenhouse gas emissions and fossil fuel dependence; improving poor air quality in cities; reducing congestion and improving urban public space and quality of life. At present, however, there is considerable uncertainty over how far-reaching changes to travel and lifestyles in cities are likely to be. Are current trends in new urban mobility restricted to particular demographic and social groups in cities? To what extent are urban residents keen to adopt new travel opportunities, or are car-dependent lifestyles and related attitudes entrenched and resistant to change? Are current changes towards more sustainable travel patterns limited to inner cities or can these changes also be transferred to suburbs and more widely across city-regions?

Answering these questions requires improving our understanding of urban travel patterns and lifestyles, and the attitudes and behaviours of different demographic groups to changes and innovations in travel opportunities. This research addresses this task by improving the evidence base of attitudes and behaviours towards new urban mobility trends. An in-depth telephone survey was conducted with 1,184 respondents in London and 2,400 in four German cities, of which 987 respondents live in Berlin. The survey investigates the demographics, residential situation, travel behaviour patterns, and attitudes towards current mobility and housing opportunities. Furthermore the survey focuses on attitudes and behaviours in relation to new urban mobility opportunities, including bike and car sharing, electric cars, cycling and smartphone travel apps. These more novel aspects of travel behaviour are at the forefront of current travel behaviour dynamics, yet are less well understood and their future potential is uncertain.

This report presents the results from a comparative investigation on travel behaviour and attitudes in Berlin and London in six sections. Following the Introduction, Section 2 gives an overview of new urban mobility trends in Europe, providing the context for the case study cities of Berlin and London. It also introduces characteristics of the survey and sample used in this investigation. Section 3 summarises the most important descriptive trends in Berlin and London. Section 4 presents the mobility attitude groups derived from sample segmentation, describes their characteristics and what they reveal about prevalent travel behaviours and potential to embrace new mobility opportunities. Section 5 provides policy recommendations for each attitudinal group followed by a conclusion in Section 6.

1.2. The case study cities: Berlin and London

This study focuses on two case study cities and their metropolitan region, London and Berlin, with the intention of capturing the contemporary patterns and trends of new urban mobility. As well as having historical aspects in common, principally their heritage as European capitals built around large public transport systems, London and Berlin share many contemporary trends in relation to new urban mobility. Both cities are highly dynamic and are experiencing extensive socio-economic pressures, with high levels of national and international in-migration and related processes of inner-city gentrification. Both cities have forward-thinking city governments that have implemented a series of progressive land-use and transport planning policies through investing heavily in public transport, walking, cycling and the public realm. Furthermore, both cities have thriving tech industries and are using this economic specialisation to foster innovation in electric vehicles, car sharing schemes, smart cards and mobile travel apps.

The combination of these shared factors means that London and Berlin can be considered to be ahead of the curve in terms of changing travel patterns and lifestyles. Both cities are therefore interesting research exemplars for identifying new travel behaviours and lifestyle dynamics, and changing patterns in relation to car ownership and ICT innovation.

Whilst London and Berlin have much in common, there are also clear differences between the two cities in urban form, policies and histories. The contrasts between Berlin and London also extend to mobility and transport patterns and can be used to identify in which areas each city has been relatively successful or had the greatest problems, and to see where best practices can be shared between them. For instance Berlin's long existing culture of cycling has shaped comprehensive cycling plans, while London has made significant advances in areas such as congestion charging.

2. Towards New Urban Mobility

2.1. Urban change

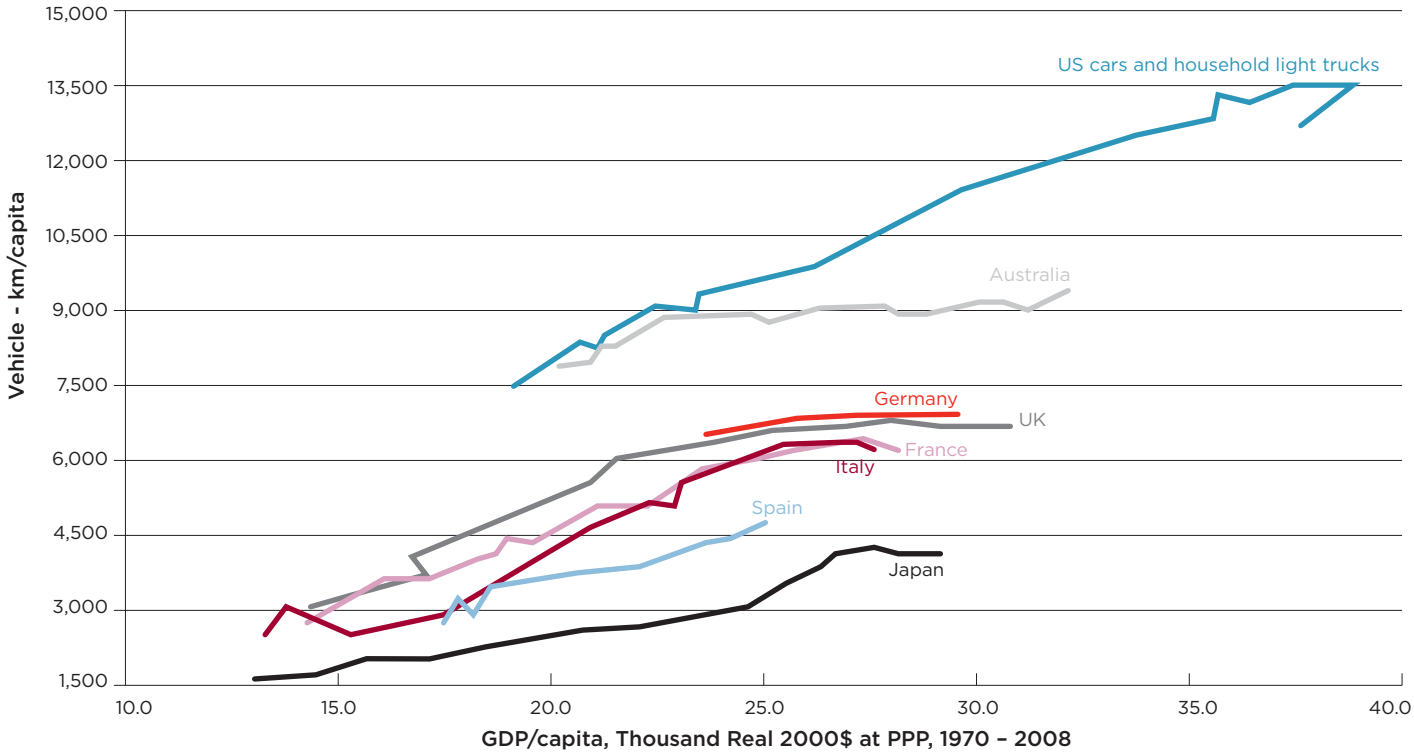
In recent decades, many OECD cities have been affected by significant socio-economic change. And several of these changes have also impacted on the physical development of the city, leading to a revived interest in re-developing inner city areas to accommodate increasing urban populations. This 'return to the city' is informed by the agglomeration dynamics of post-industrial economic development; changing demographics and family structures; greater participation of women in the labour market; and related lifestyle changes. These have all been identified as significantly reducing the attraction to suburban living (Aguiléra, Wenglenski et al. 2009, Lovejoy, Handy et al. 2010, Rérat 2012). In addition, many of the historical reasons that underpinned the decline of inner-city areas - such as pollution from factories and coal fires, overpopulation and poor sanitation - no longer persist in many contemporary cities in the developed world.

The densification and revival of inner cities has also been facilitated by changes in urban planning policy. Since the early 1990s, broader concerns about the effects of urban sprawl and the decline of city centres became aligned with an improved understanding of their negative environmental impacts. As a result, compact city planning concepts were established, promoting increased urban densities and mixed use development integrated with public transport and pedestrian friendly urban neighbourhoods. These policies aimed to reduce environmental impacts through reduced car use, improve the quality of life in vibrant urban centres at multiple scales, and preserve land through higher density development and reduced sprawl. As a result of all of these factors, measurable change in urban development is observable in many cities. For example, since 2000, population growth in London has been concentrated within a 10km radius of the city centre; and between 2004 and 2011, 53 per cent of all newly constructed floor area was located within walking distance (0-500 metres) of a rail or underground station (Burdett and Rode 2012).

2.2. New alternatives to the automobile

In parallel with the densification of cities and socio-spatial change, there have also been very significant shifts in car use and attitudes towards car ownership (Canzler and Knie 2015). After car use in developed world cities and countries increased substantially throughout the 20th century, data indicates that around the early 2000s, a plateau in vehicle miles travelled was reached. This pattern can be seen in the USA, Canada, Japan, France, Germany and the UK as

Fig. 2.1. Annual vehicle kilometres against wealth levels: 1970-2008
Source: Goodwin 2012b



shown in Fig. 2.1. Note that the trend is quite different in emerging economies such as China and India, where car use continues to rise.

There does not appear to be a dominant factor to explain why car use is levelling out in advanced economies. Instead a range of factors are likely to be influencing behaviour. Price has been a significant factor, with increases in fuel prices coupled with squeezed incomes, particularly since the recession which began in 2007. These income pressures have reduced household budgets and many have cut back on driving. Demographic factors may also be significant as groups with traditionally lower car ownership, such as students and the elderly, represent increasing proportions of advanced economy populations.

Car ownership and use also interact with the other factors discussed above, such as increasing urban density and new transport technology. Inner-city populations have expanded, allowing residents access to a wide range of services and jobs without the need to own a car. New transport services, such as car and bike sharing, give urban residents increased flexibility. The Internet may also be contributing to reduced passenger trip rates, as activities such as shopping, socialising and many work tasks can be conveniently performed online.

In addition to the pollution impacts of urban car travel, critics have pointed to the way in which driving isolates urban residents both from each other and the urban environment (see InnoZ 2014). Important aspects of the social role of cities and maintaining urban community can be undermined by excessive car use through the deterioration of urban interaction and public space. Furthermore, car use has been linked to a range of negative health impacts. The current promotion of 'active travel' or the 'slow modes' of walking and cycling has been a response to these concerns. Reclaiming road space is a key aspect of this change and cuts across design interventions such as the pedestrianisation of city streets, pavement widening and cycle lanes.

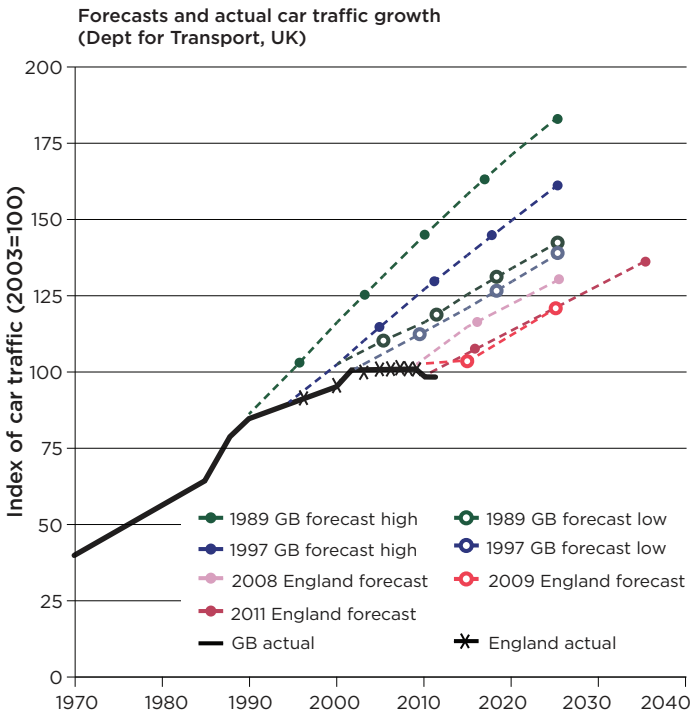
2.3. Digital technologies and transport innovations

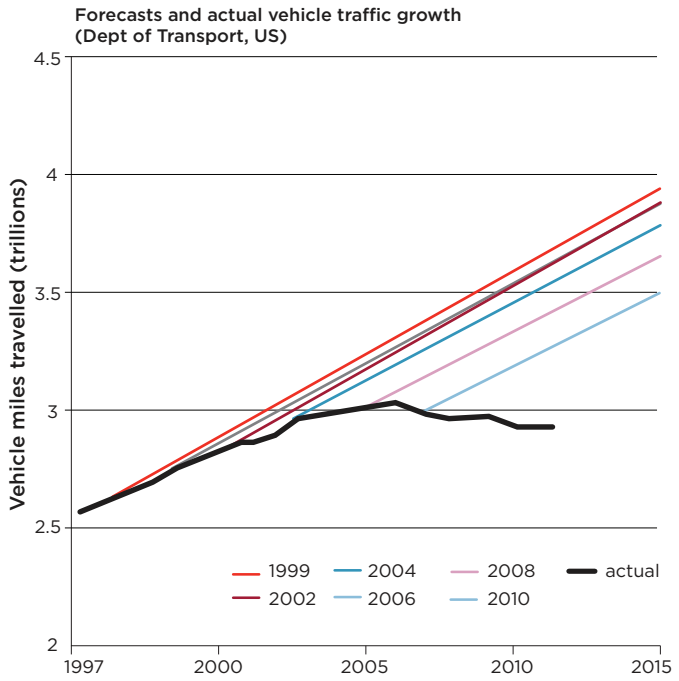
One particularly important factor that has led to changes in urban mobility is the role of digital technologies. Digitisation and ICT have already brought transformative social and economic change, starting with the development of the Internet, to social media platforms and subsequently widespread smartphone and mobile computing device adoption. These changes have radically affected how we communicate, socialise, shop and consume media. Entire industries, particularly relating to traditional media, have been profoundly challenged by these changes.

Transport has also been greatly affected by ICT and with the current pace of innovation further change seems inevitable. In the last two decades public transport has been transformed by real-time information, online route finding and ticketing available through mobile devices. This has significantly improved the experience of using public transport for passengers, minimising uncertainty and improving flexibility. ICT has similarly affected the experience of driving, through satnav devices and online services such as parking availability platforms. Yet the potential of digital innovation in transport is not only to improve existing transport services but to create entirely new mobility amenities. The most prominent recent trend has been the way in which ICT platforms have enabled efficient and convenient provision of transport services such as car sharing and new taxi services. These new possibilities are challenging traditional concepts of ownership and access in relation to transport services, and are creating new hybrid forms of public-private transport.

Beyond digitisation, new technology more directly tailored to urban transport focuses mainly on further electrification of urban mobility systems. Unlike the introduction of electric railways, trams and elevators at the turn of the last century, this second wave of electrification is focused primarily on allowing electric vehicles to operate with stored electricity, eliminating the requirement for constant grid connection. High energy conversion rates (around 80 per cent for electric vehicles compared to 25-30 per cent for internal combustion engines (ADB 2014, IPCC 2014)), elimination of local air pollution and the reduction of noise are among the key advantages of further electrifying urban transport. Several European and North American cities have also combined electric vehicle strategies with car sharing services (Grebert 2014). The largest of this kind is Paris's Autolib' programme, with 3,000 vehicles and 1,200 stations (Huré 2012). In addition, the electrification of public transport is being driven by the increasing adoption of hybrid and electric bus technologies which have been shown to deliver on average a 37 per cent improvement in fuel economy and energy production through regenerative braking systems (Chandler and Walkowicz 2006).

Fig. 2.2
False projections of car traffic growth
Source: Goodwin 2012a (top) and Williams-Derry 2013 (bottom)





2.4. The knowledge gap

Given the disruptive force of the innovations outlined above, which are undoubtedly impacting on urban transport and mobility, it has become increasingly difficult to operate with a traditional 'predict-and-provide' model of urban transport planning. Most importantly, it should be noted that there is a considerable risk of overestimating the growth of private vehicle stock and car use, as most growth projections simply extrapolate historic trends without adequately incorporating evidence on changing patterns of mobility and their relationship to income and economic growth (Goodwin 2012, Williams-Derry 2013, Green and Naughton 2014). For example, analysis of recent traffic forecasting in both the UK and US has indicated that transport planners have consistently overestimated future car traffic growth in the previous two decades, with significant distortive effects on transport planning investments (see Fig. 2.2).

More useful analysis to assist urban transport planning will have to better capture the underlying forces that affect urban travel. This study will consider one aspect of these underlying forces: the broader attitudinal characteristics of urban residents with regards to different urban transport modes; and the degree to which these attitudes may be an important factor in anticipating future changes in travel behaviour.

2.5. Travel attitudes and behaviour: a study of mobility styles

Given the current trends in transport and the knowledge gaps in travel and mobility research, this study focuses on a number of aspects to understand the personal motives behind travel behaviour.

Subjective orientations – The psychological dimension of behavioural change in transport has been poorly understood to date, although the field has seen an increase in transport studies applying psychological models to explain mobility choices and other aspects of daily travel. The most widely applied model is the theory of planned behaviour (TPB), which was developed in the context of behavioural psychology, and states that individual behaviour results from beliefs as to anticipated consequences of an action. These beliefs are further influenced by personal values, perceived social norms and the perceived feasibility of an action (Ajzen 1991). Questionnaires on attitudes towards aspects of travel mode and travel experience make it possible to measure the social constructs that influence travel behaviour (Schäfer et al. 2012, Möser and Bamberg 2008). These constructs can be extended to wider, sociological constructs of lifestyles, symbolic values of mobility, social values and environmental attitudes. By drawing on our representative survey of the residents of Berlin and London, we build on these constructs and seek to extend the study of attitudes through four additional aspects:

Technology – Information and communications technology (ICT) is seldom acknowledged as an aspect affecting travel, although it increasingly shapes the decision context of daily mobility. Real-time information on arrival and departures, electronic journey planners, booking systems transmitted through smartphone applications and online platforms are widespread services facilitating instant access to information and inter-modal travel. We argue that capturing attitudes towards technology may provide important insights into the most appropriate channels for intervention to spur behavioural change.

Residential preferences – Where we live is a product of complex decisions informed by preferences with regards to travel, type of housing and the residential environment. Yet residential selection has rarely been considered in studies of travel attitudes. In this study we are interested in capturing the interactions between residential preferences and choice of travel.

Geographic context – We geocoded respondents by their residential location in order to describe residential context more formally through urban form descriptors or social indicators of neighbourhoods. Contextual constraints and opportunities play an important part in the way we travel and our attitudes towards daily mobility.

Cross-city comparison – Travel attitudes and behaviour differ from place to place and are often shaped by local mobility cultures. In cities such as Amsterdam, Berlin or Copenhagen, new developments without provision for extensive cycling infrastructure would be unthinkable because cycling is perceived as a central element in travel. Local transport policy regimes also affect the way residents think and go about their daily mobility. Comparison designs are novel in the study of travel attitudes, but have the potential to capture the macro forces influencing urban travel.

Fig. 2.3. Sampling regions in Berlin and London
Source: LSE Cities

2.6. Sample

Computer-aided telephone interviews (the so-called CATI method) were conducted with 987 individuals in Berlin and 1,184 individuals in London who were aged 18 or over. The sample was drawn from the two administratively defined cities as well as the wider metropolitan region, which in London roughly corresponds to the inner commuter belt (see Fig. 2.3). The samples represent a population of approximately 12 million people in London and four million people in Berlin. Sample weights ensured that respondents were representative for the administrative urban areas and the surroundings.

Sampling routines differ in Germany and the UK. In Germany, it is common to use random sampling with random digital dialling (RDD) as the sampling frame. In the UK, sampling is typically achieved by quota sampling.

3. New Urban Mobility in Berlin and London

This section discusses current travel patterns and provides a general picture of mobility in Berlin and London: how they are similar and how they differ. This is followed by a descriptive analysis of the LSE Cities/Innoz survey data, which provides an observation of general patterns in travel attitudes and behaviours in the two cities. The questionnaire asked broadly about socio-demographics, car ownership, residential location and any intentions to use new forms of travel, including electric vehicles.

3.1. Berlin

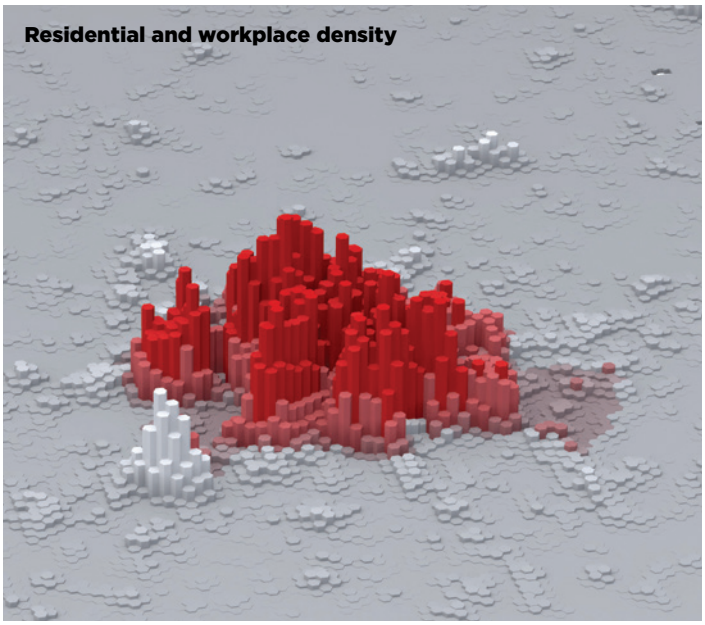
Context: urban form and public transport trends

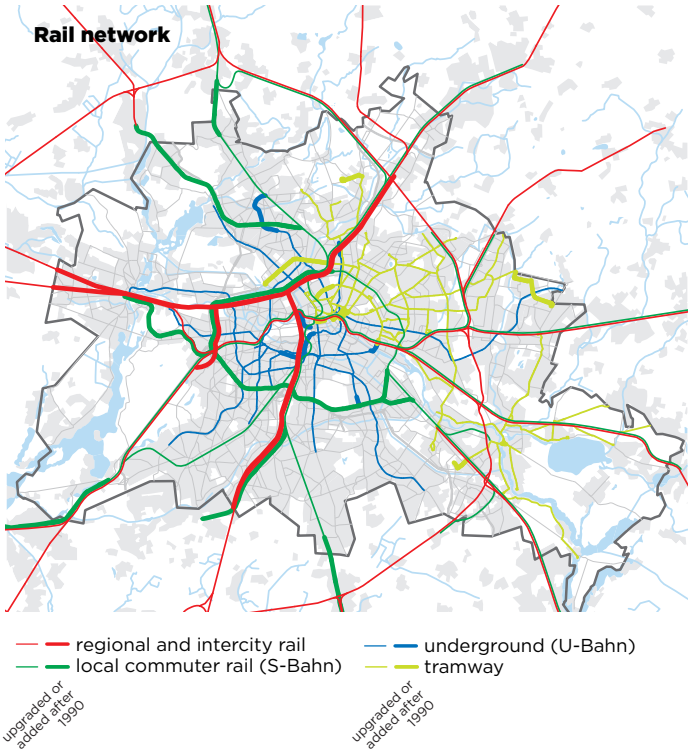
The metropolitan region of Berlin comprises the city of Berlin as well as a further 18 local authorities in the city's vicinity. In 2013, the metropolitan region had a population of 4.4 million people, of which 3.5 million people (80%) lived within the city boundaries of Berlin (Statistical Office Berlin-Brandenburg 2015). Within the city of Berlin, residential densities tend to be high in the inner-city districts of Mitte, Friedrichshain and Kreuzberg; these areas are also home to major commercial and business activities and constitute the main destination of daily commuting and shopping trips.

Berlin has only recently begun to reverse a trend of little or no growth. In 2013, Berlin registered a population 5.6 per cent larger than compared to 2000. In the same time period, the city also witnessed an increase in one-person households (Brandenburg State Office for Building and Transport 2014; Senate Department for Urban Development and the Environment 2013; Senate Chancellery Berlin and State Chancellery Brandenburg 2015). The surrounding local authority areas have grown more rapidly, with population growth registered at 14.2 per cent over the same time period (see Fig. 3.2). This trend towards suburbanisation has been observable across Germany since reunification, and to some extent before this in former West Germany.

The impact of suburbanisation on travel and mobility can be seen in the form of rising commuter travel distances. This emerging travel demand has generated investments in both the road network and public transport infrastructure in the region. One of the most significant, large-scale developments to enhance regional connectivity is the so-called "mushroom concept" (*Pilzkonzept*), a project set to increase rail capacity both within and through Berlin. The recently constructed Berlin Hauptbahnof (main station) is perhaps one of the best known landmark project of this scheme. The station created a new

Fig. 3.1. Urban density and recent additions to the rail network in Berlin
Sources: LSE Cities based on LandScan 2010 (left) and Senate Department for Urban Development and the Environment 2013 (right)





interchange between wider east-west and north-south rail services. Further elements of the scheme included a new southern high-capacity rail extension as well as a northern tangential connection. The impact on regional connectivity and commuter flows is said to have been considerable: the newly constructed infrastructure allowed increased service levels (regional commuter train services more than tripled after inauguration in 2006), as well as shortened travel times (by up to 35 minutes) and more opportunities for regional-local interchange (punkt 3 Magazine 2007).

Between 2001 and 2011, annual public transport passengers increased from 1.14 to 1.38 million (+20%). During the same period, the relative share of public transport remained the same while cycling and walking increased considerably. The decrease in car use was the most significant change. During this period, the motorisation rate also decreased. The share of zero car households was approximately 40 per cent in 2013 and tended to be higher in Berlin's denser, inner-city neighbourhoods where the proportion of one-person households is higher too. The introduction of a low emission zone (Umweltzone) in 2008 restricted inner-city neighbourhoods to certified low-emission vehicles.

Fig. 3.2. Population development in the metropolitan region of Berlin
Sources: Brandenburg State Office for Building and Transport 2014, Senate Chancellery Berlin and State Chancellery Brandenburg 2014

	population (thousands) 2000	population (thousands) 2013	net change (thousands)	net change (%)	average annual growth rate
Berlin	3,331.2	3,517.4	186.2	+5.6	+0.4
Berlin surroundings	805.11	919.8	114.6	+14.2	+1.0
Total region	4,136.3	4,437.2	300.8	+7.3	+0.5

Fig. 3.3. Modal share for all trips and all trips to work in Berlin
Sources: Senate Department for Urban Development and the Environment 2013 and Technische Universität Dresden 2014

	modal share 1998 (%)	modal share 2013 (%)	net change (%)	work trips 2013 (%)
public transport	27	27	-0.1	39
driving	38	30	-8.4	34
walking	25	31	+6.0	14
cycling	10	13	+2.5	14

Fig. 3.4. Development of motorisation in Berlin city
Source: Senate Department for Urban Development and the Environment 2013

	2000	2013	net change	net change (%)
cars	1,191,994	1,149,520	-42,513	-3.6
motorisation rate (per 1,000)	358	327	-31	-8.7
zero car households	n/a	40%		

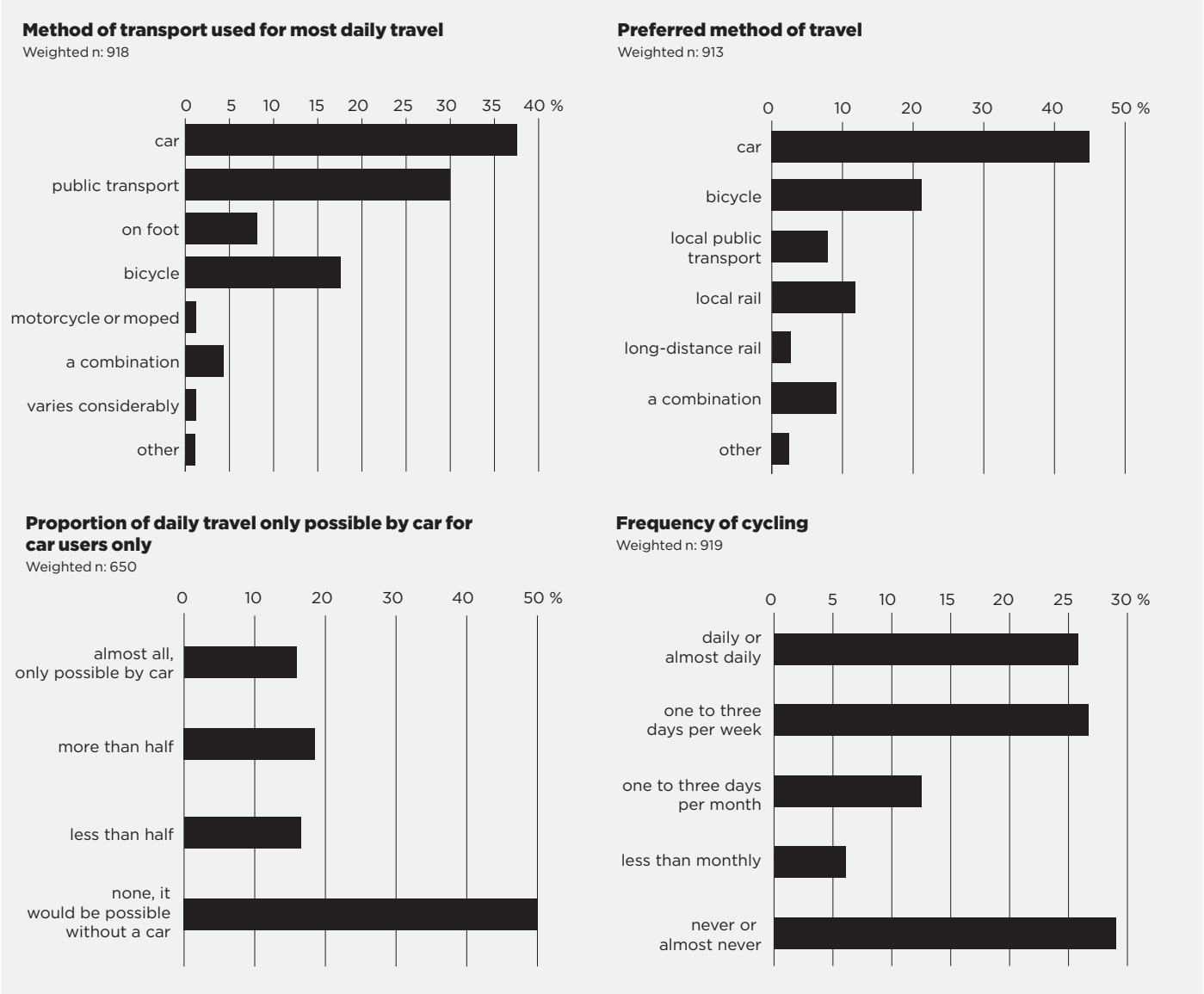
The ambition was to reduce pollution in Berlin and the policy may also have contributed to a further concentration of zero-car households in Berlin's centre.

An important component of Berlin's transport policy has been planning for cycling and walking. On average, Berlin residents walk or cycle four out of ten trips. Berlin has built over 1,000 km of cycling infrastructure and the number of cyclists has been rising at a constant rate since the 1970s (+40% between 2004 and 2012). The impact of cycling investment is reflected in the comparatively higher share of cycling for all trips and for work trips within Berlin.

Travel behaviour and use of alternative modes

Moving to the results of the LSE Cities/InnoZ survey conducted for this study of the metropolitan population, the most commonly used modes for daily travel among survey participants are shown in Fig. 3.5. Car travel is the most common with 37 per cent, followed by public transport at 30 per cent and a remarkably high cycling rate at 17 per cent. Walking comes in at eight per cent. This makes an interesting comparison to the follow-up question of which travel mode Berlin participants most prefer to use. Here, preference for car travel increases to 45 per cent and

Fig. 3.5. Selected descriptive statistics of travel behaviour among Berlin respondents



cycling also increases to 21 per cent, while public transport drops to 22 per cent.

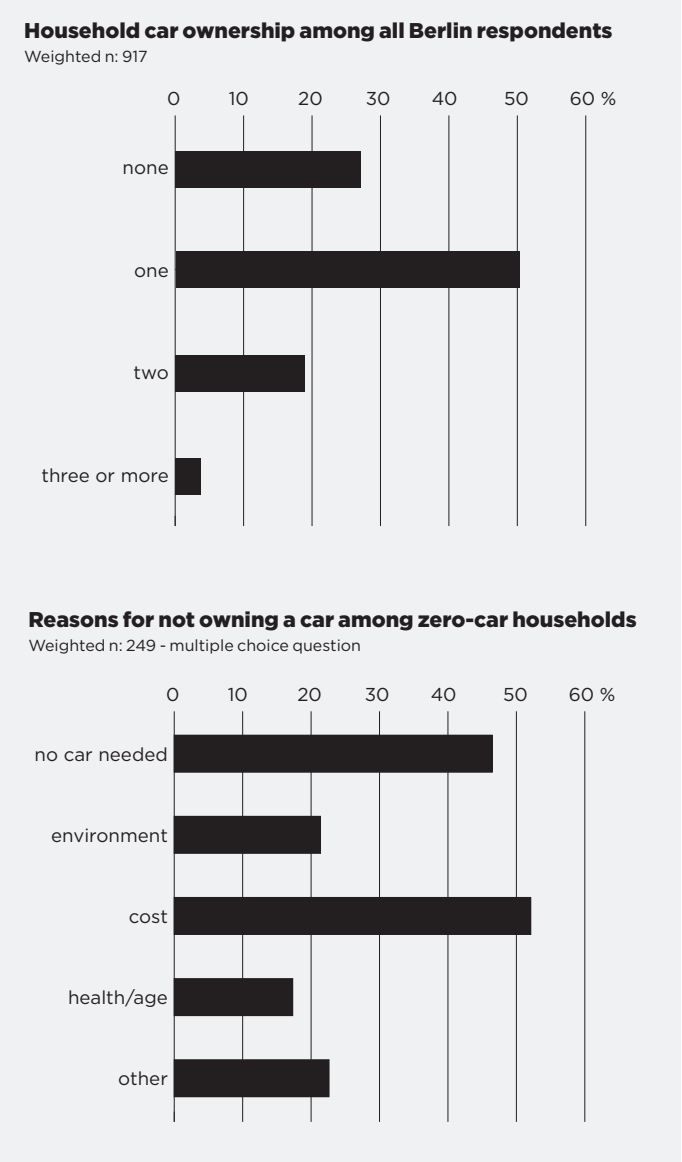
Survey participants who are car users were also asked how much of their daily travel was only possible by car, or could have been achieved using other modes. The response reveals that half of car users felt that all their daily travel would have been possible without a car. Only 16 per cent answered that almost all their travel was only possible by car. This indicates that many car users live in locations that are accessible by alternative modes. It also demonstrates awareness among car users of these alternatives. It does, however, mean that many residents use their car regardless of other options, and clearly have a preference for car travel.

High levels of cycling are clearly one of the main success stories of sustainable transport planning in Berlin. More than half of survey participants (52%) cycle at least once a week, and only 29 per cent of participants do not cycle at all. Clearly cycling use has permeated through a wide range of demographic groups in the city. One common factor that tends to restrict urban cycling is road safety and the perception of danger when cycling. Nearly one in two Berlin respondents (48%) agreed that cycling is dangerous in Berlin. Clearly this remains an issue in Berlin, with three quarters of participants tending to agree more than disagree with this statement.

Car ownership and car sharing

Availability of cars is relatively high in Berlin. Households that do not own a car make up 27 per cent of households surveyed and are in the minority (Fig. 3.6); yet they are still a substantial proportion of respondents. A related question revealed that three in four respondents who possess a driver's licence have a car available to drive at all times. The survey asked non-car owning households what their main reasons for choosing not to own a car were. The most common reasons were 'Cost' and 'No Car Needed' – reported by 53 and 47 per cent respectively – indicating that convenience and budgeting issues seem to be most strongly influencing behaviour. Environmental reasons were cited by 22 per cent of participants and health reasons by 18 per cent.

Fig. 3.6. Car ownership in Berlin

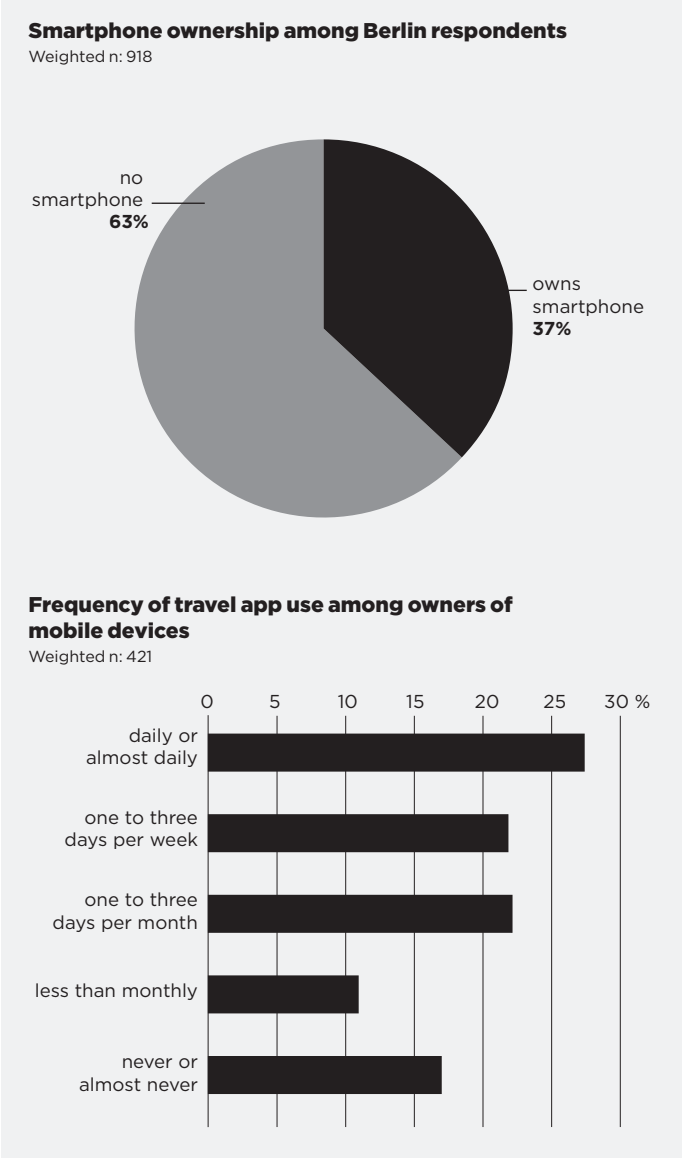


Car sharing is an increasingly popular option for those who want car access in cities without having to own a vehicle. Yet only 3.4 per cent of respondents had at least one car sharing member in the household. This is low, indicating that there is still a long way to go before car sharing makes a widespread impact on current travel in Berlin. Most of the respondents who indicated membership, however, joined after 2011; this may hint at the beginning of an upward trend in car sharing uptake albeit on statistically uncertain terms.

ICT and travel behaviour

ICT is playing an increasingly important role in travel behaviour, particularly in relation to public transport. The survey included a number of questions to gauge how significant aspects of ICT were in travel choices. The extent of smartphone ownership amongst survey participants is shown in Fig. 3.7, with 37 per cent of participants owning a smartphone with internet access. This is relatively low, and may reflect the exclusion of people younger than 18 from the survey. Among smartphone owners, travel apps are used frequently. Daily use was recorded by 28 per cent of participants. A further 22 per cent used travel apps one to three days per week.

Fig. 3.7. Smartphone use in Berlin

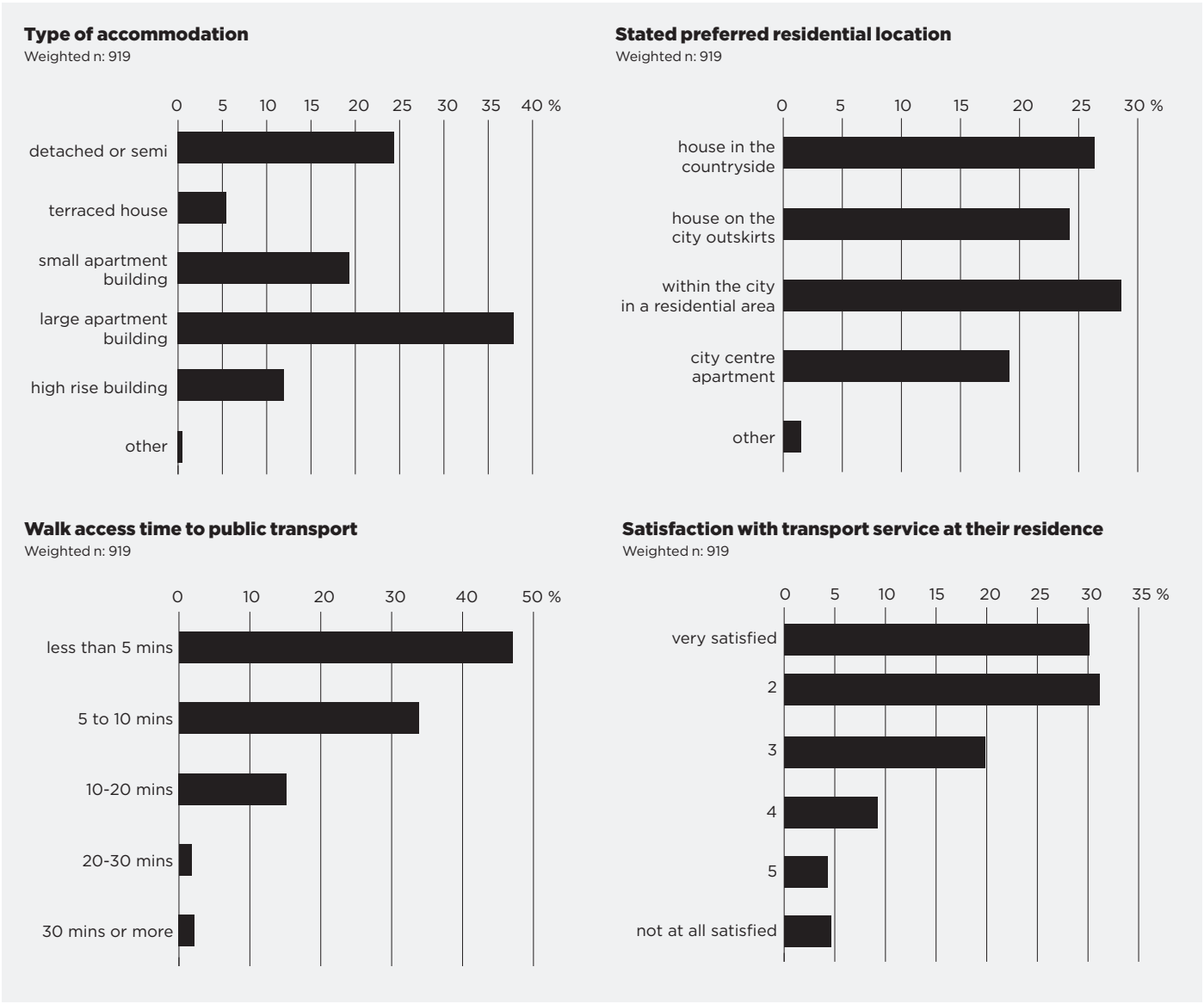


Residential preferences

Accessibility and travel opportunities are strongly influenced by residential location, and so understanding residential patterns and preferences are a vital part of understanding travel behaviour. This questionnaire covered housing types, residential preferences, public transport accessibility and housing satisfaction.

The housing type recorded by survey participants is shown in Fig. 3.8. High density forms of housing are prominent among Berlin respondents, with large apartment buildings being the most common housing type at 38 per cent. Detached or semi-detached housing comprises 24 per cent of respondents. Although higher density housing is the most common form in Berlin, responses to ideal residential location are more evenly divided between urban and more suburban locations. Prevalent high density housing in the sample does not translate into perceived strong public transport accessibility. While one in two respondents (53%) are very satisfied with their current residence, the same degree of satisfaction with current travel opportunities is lower at 30 per cent (Fig. 3.8).

Fig. 3.8. Selected descriptive statistics in relation to respondents' place of residence in Berlin



3.2. London

Context: urban form and public transport trends

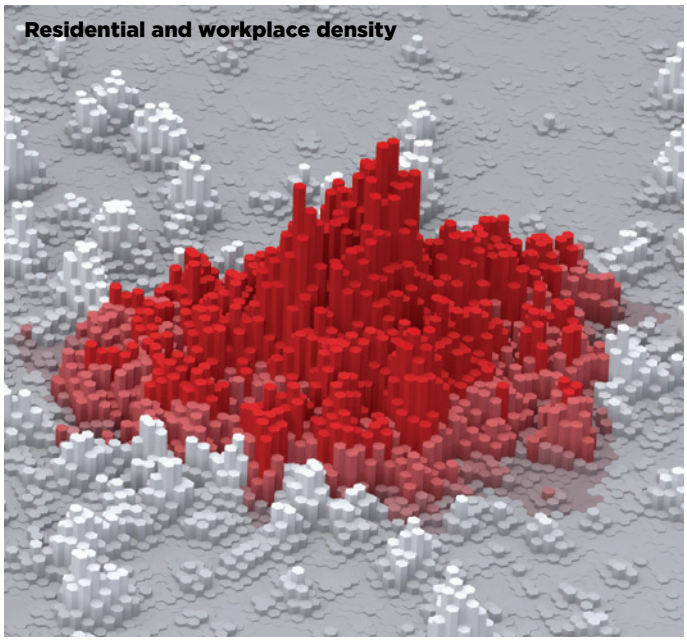
Drawing on data from the 2001 and 2011 censuses, the overall story of change in London is one of significant growth, densification and reinvestment in public transport infrastructure. Between 2001 and 2011 Greater London grew at a rapid rate, gaining one million new residents in that period leading to a total population of 8.17 million. In early 2015, London's population surpassed its historic 1939 peak of 8.6 million. Fig. 3.9 also highlights that London's population growth was concentrated in the inner-city, with a 17 per cent population increase in Inner London compared to a 12 per cent increase in Outer London, and a marginally higher absolute population rise in Inner London. This is consistent with the inner-city densification patterns discussed in Section 2.1. Rapid population growth has further widened the differences in scale between London and other UK city regions.

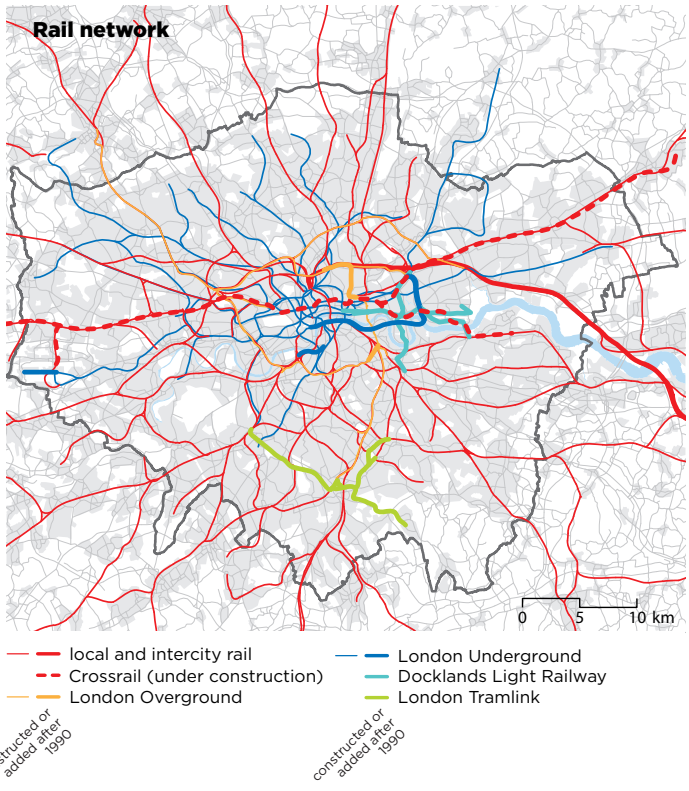
The substantial population growth in London is linked to changes in urban form, with inner-city densification and high demand for new housing. Changes in population have been most dramatic in Inner East London, where major regeneration programmes at Docklands and the Olympic Park have been located. Inner East London boroughs have experienced very high population increases, including the

Fig. 3.9. Inner and Outer London population development
Source: NOMIS 2014

	population (thousands) 2001	population (thousands) 2011	net change (thousands)	net change (%)	average annual growth rate
Inner London	2,980.5	3,486.5	+505.9	+17.0	+1.6
Outer London	4,191.6	4,687.5	+495.9	+11.8	+1.1
Greater London total	7,172.0	8,173.9	+1,001.9	+14.0	+1.3

Fig. 3.10. Urban density and recent additions to the rail network in London
Sources: LSE Cities based on LandScan 2010 (left) and Greater London Authority 2011, Open Street Map 2014 (right)





centre of the Docklands development, Tower Hamlets, at 27 per cent, the Olympic borough Newham at 24 per cent, and neighbouring Hackney at 20 per cent. This growth pattern is re-establishing and reinforcing the traditional compact city form of London. Ambient density (a modelled average of residential and workplace density) is mapped in Fig. 3.10, which highlights this dense inner-city pattern. Average residential density levels in Inner London are 2.5 times higher than the Outer London average.

The densification of Inner London is closely tied to the London Plan, the Greater London Authority's spatial strategy for land use and transport planning, first published in 2004 and updated in 2008 and 2011. Increasing urban densities at public transport hubs has been a key policy goal of all the London master plans. This has been implemented by tying development densities to public transport accessibility levels, as well as prioritising development in inner-city and metropolitan centre brownfield sites through Opportunity Areas and Areas of Intensification policies. The net effect has been to facilitate inner-city densification, particularly in Inner East London where public transport improvements and regeneration schemes have been concentrated. The scale of new public transport infrastructure can be seen in Fig. 3.10, which maps the major new underground and rail links implemented over the last 15 years. The focus on the inner-city, and particularly Inner East London, is clear. New infrastructure has been combined with extensive upgrades to existing underground lines, rail links, bus services, cycling infrastructure and the public realm, as well as increasing restrictions on car use through, for example, the introduction of the London Congestion Charge. The net result has been a comprehensive upgrade and enhancement of the entire London public transport system.

With the substantial densification in London's urban form and large-scale renewal of its public transport system, one would expect significant changes in travel behaviour. Indeed, a pattern of increasing public transport use and falling levels of car use, both in proportional and absolute terms, can be seen (Fig. 3.11). Cycling trips have doubled in absolute terms between 1998 and 2013, although they still remain fairly low in proportional terms at 2 per cent of all trips.

Perhaps the most fundamental indicator of travel behaviour is car ownership, with the proportion of households choosing not to own a car indicative of whether alternative travel modes are sufficient to provide for their accessibility needs. Fig. 3.12 shows that the number of households that do not own a car in London increased by over 250,000 between 2001 and 2011. 41.6 per cent of all households do not own

Fig. 3.11. Modal share for all London trips (journey stages) and all work trips (London residents)
Sources: Office for National Statistics (2013) and Transport for London (2014)

	modal share in all trips 1998 (%)	modal share in all trips 2013 (%)	net change (%)	all work trips 2011 (%)
public transport	33	45	+12	54.4
driving	45	33	-12	32.4
walking	22	21	-1	9
cycling	1	2	+1	4.2

Fig. 3.12. Inner and Outer London change in zero car households
Source: NOMIS 2014

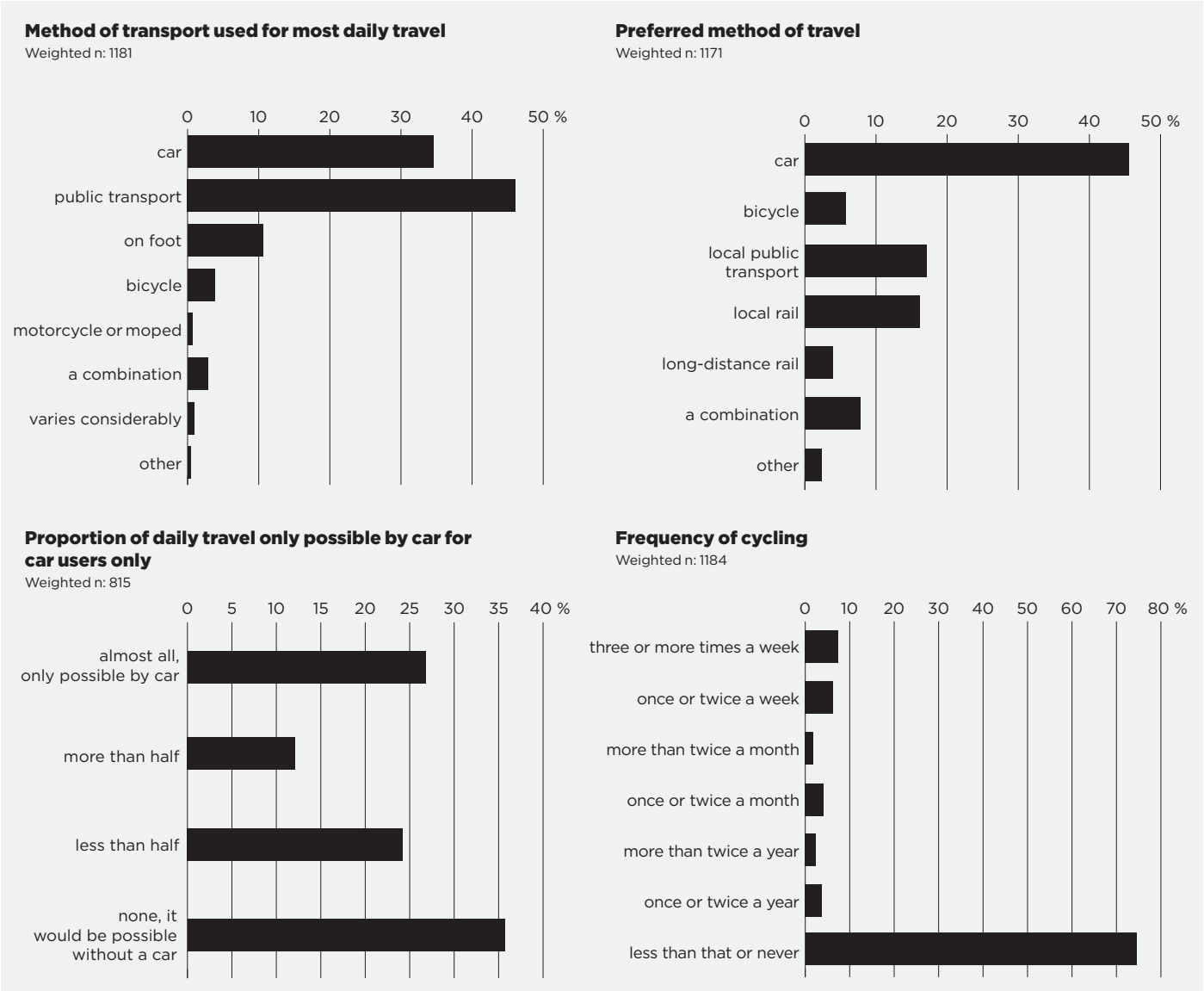
	households (thousands) 2001	households (thousands) 2011	percentage 2001	percentage 2011	net change (%)
Inner London	1,312.6	1,464.9	49.9	55.7	+5.8
Outer London	1,703.6	1,801.3	27.9	30.0	+2.1
London total	3,016.0	3,266.2	37.5	41.6	+4.1

a car, a rise of 4.1 per cent. There is a clear concentration in Inner London, where the number of zero car households has grown by 5.8 per cent to reach a total of 55.7 per cent. Meanwhile in Outer London, the proportion of zero car households is just 30 per cent and is increasing more slowly. These differences between Inner and Outer London car ownership levels reflect the patterns of urban form and public transport infrastructure discussed above.

Travel behaviour and use of alternative modes

Results from the London component of the LSE Cities/ InnoZ survey suggest that public transport and the car are dominant in the daily travel habits of the London respondents (Fig. 3.13). Use of public transport is particularly high at 46 per cent. Active travel modes are relatively modest, at 11 per cent for travel on foot and 3.8 per cent for travel by bike. However, it should be appreciated that walking is integral to a public transport trip, and in London these can often represent significant distances.

Fig. 3.13. Selected descriptive statistics of travel behaviour among London respondents



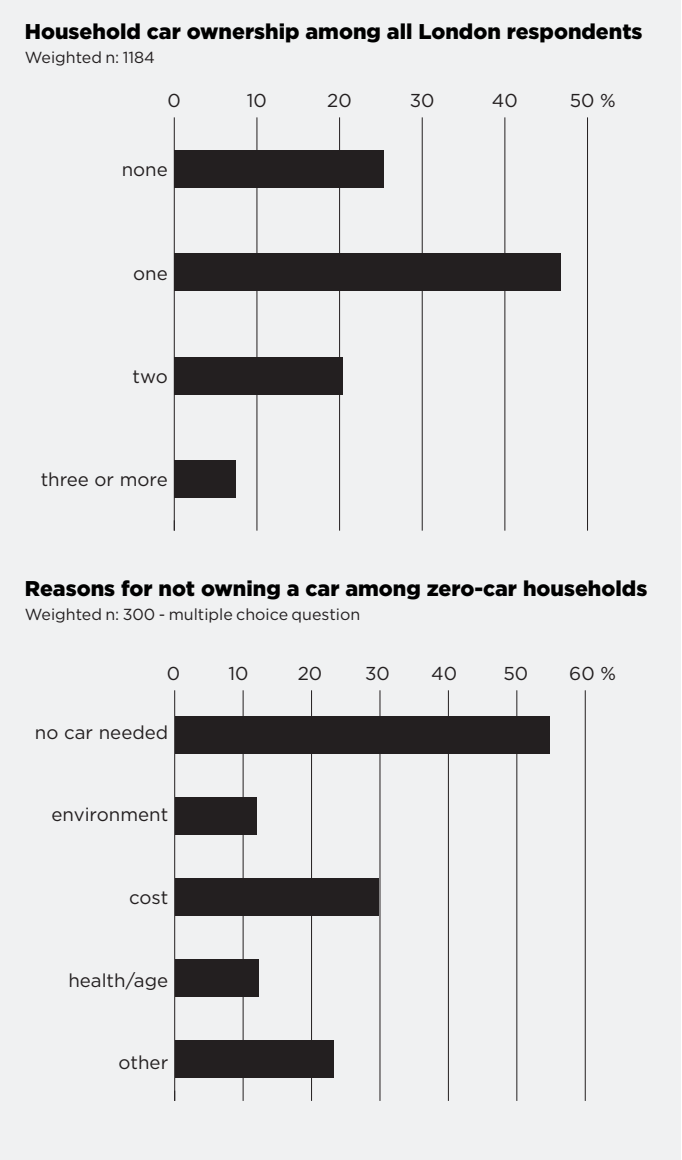
The two top charts of Fig. 3.13 make an interesting comparison as they contrast actual mode use against the travel mode participants would prefer to use. Here, car travel is the preferred mode for half of the respondents. Combining the responses on mode preferences highlights that 37 per cent of participants prefer public transport, nine per cent lower than actual use. Cycling as a preferred mode of travel is higher at six per cent, which is still modest considering 31 per cent responded that they had a bicycle available to them at all times.

Much of the focus on sustainable travel is on reducing car trips and shifting travel to alternative modes. This is not always straightforward to achieve, particularly in situations where there is a lack of public transport services and accessibility to alternative travel modes is not comparable to the car. London, however, does have a generally good public transport network, particularly for trips connected to the inner city, and it is important to understand whether car users consider that there are alternatives means of travel available to them. 36 per cent of respondents report that all their car travel would be possible without a car, and a further 12 per cent of participants answered that more than half of their car travel was only possible by car. As in the case of Berlin, this result is encouraging in terms of the availability of alternative modes where car owners live, and the awareness by drivers of these alternatives. It does, however, indicate that many car users prefer to use the car despite the availability of alternatives. Almost three quarters of the respondents in London cycle less than once a year or, indeed, never. This contrasts sharply with cycling among Berlin respondents, where this share is less than 30 per cent.

Car ownership and car sharing

Nearly four in five respondents (79%) who possess a driver's licence always have a car available to drive. Similarly, household car ownership is relatively high in the sample, with 75 per cent of households owning at least one car (Fig. 3.14). The main reasons why non-car owning households have chosen not to own a car were 'No Car Needed' (55%) and 'Cost' (30%), indicating that for the majority of households the decision not to own a car is based mainly on convenience, cost and lifestyle. Environmental concerns were much less significant, with 12 per cent of participants giving this as the reason, while another 12 per cent cited health/age concerns.

Fig. 3.14. Car ownership in London



Only 2.5 per cent of households included a member who was part of a car-sharing scheme. The response suggests the majority of those 2.5 per cent are Zipcar members, considered to be the dominant car sharing company in London. Respondents who joined car sharing organisations did so mainly in recent years. As in Berlin, this may indicate a trend that has just begun but the survey results do not provide enough evidence for definite conclusions.

ICT and travel behaviour

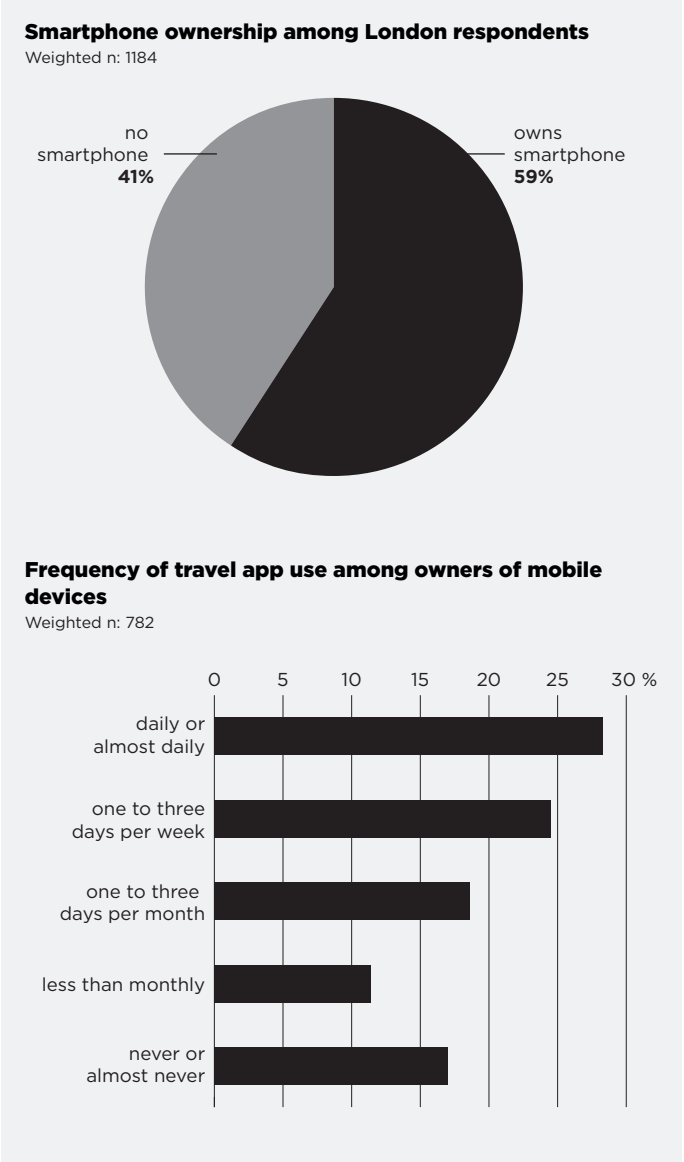
As information and communications technology is playing an increasingly significant role in mobility services and travel behaviour, we would expect this to be reflected in the results of the survey relating to ICT and use of travel apps. The ownership of smartphones is high among survey participants at 59 per cent. This provides a very large potential user base for mobility services. Travel apps are used frequently by owners of smartphones or other mobile devices (e.g. tablets). Daily travel app use was reported by 28 per cent of survey participants who owned smartphones, with a further 25 per cent using travel apps one to three days per week. Only 17 per cent of smartphone users reported never using travel apps, indicating established use amongst most smartphone owners.

Residential preferences

Traditional views of housing preferences in England are that residents generally prefer detached and terraced homes with their own garden. There is a more limited heritage of urban apartment living in England compared to continental Europe. Furthermore, low quality high-rise developments built in the 1950s and 1960s diminished the image of high density living in the UK. It is interesting to ask therefore whether the recent densification occurring in London is changing perceptions of high density living.

42 per cent of respondents live in detached and semi-detached homes, 25 per cent in terraced housing, 17 per cent in small apartments, and only eight per cent in buildings of four or more storeys (Fig. 3.16). Higher density building types clearly are a small minority amongst survey participants. On the other hand, when asked what their ideal residential location in the city would be, a substantial proportion of survey participants favoured more urban locations. A nearly equal share of respondents indicated preference for any of the following three options: house within the city in a purely residential area (29%), on the city's outskirts (28%) and in a house in the countryside (26%).

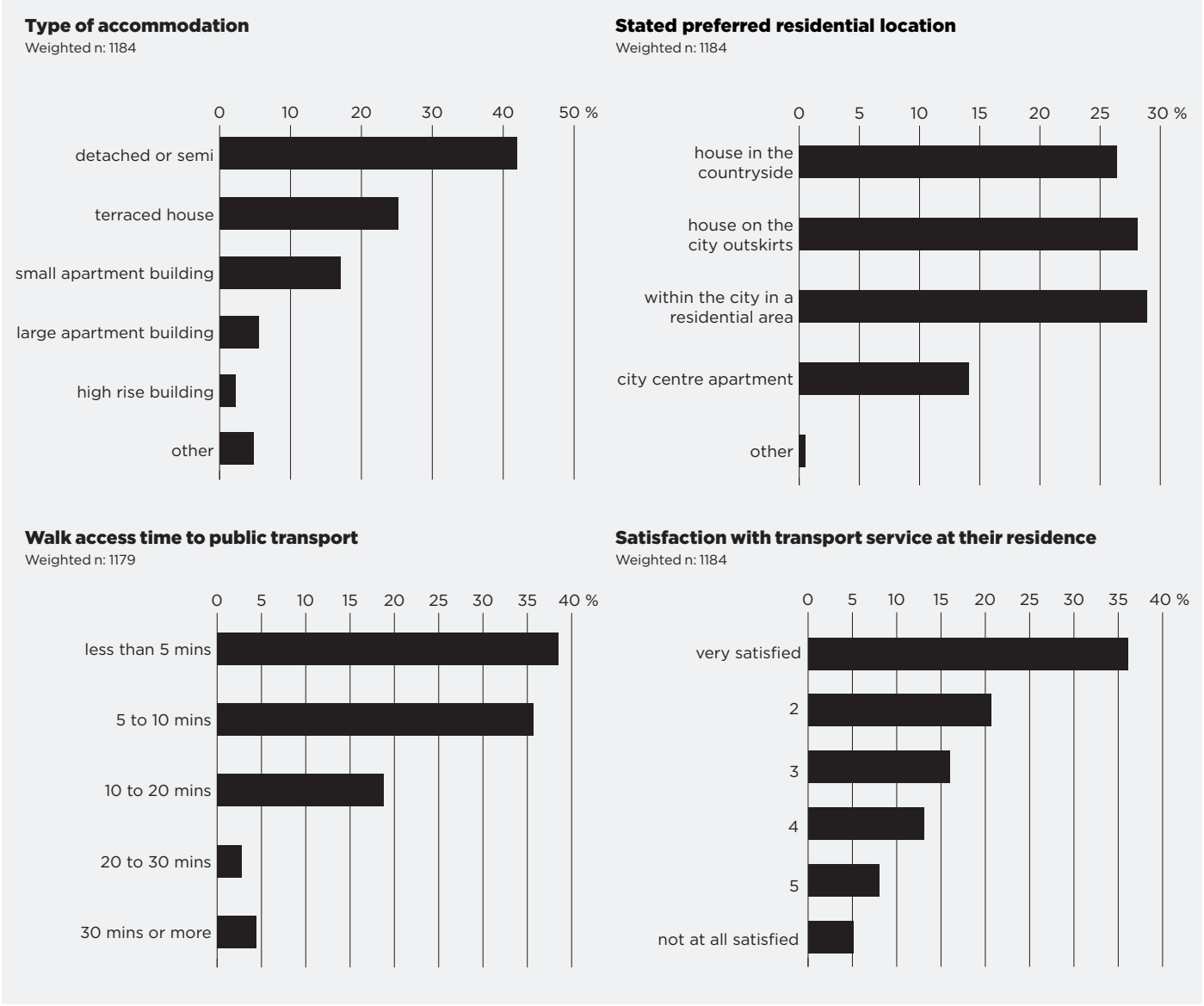
Fig. 3.15. Smartphone use in London



Despite many survey participants living in lower density housing types, the degree of accessibility to public transport services is generally very high. 38 per cent of participants are within five minutes of a public transport station or stop, with a further 36 per cent within five to ten minutes of a public transport station or stop. Despite the prevalence of lower density suburban housing types, the majority of respondents live in locations that are accessible by public transport.

The survey also asked how satisfied participants were with their current residence. This produced a very positive response, with over half of all participants (52%) answering that they were 'Very Satisfied'. The positive response to residential satisfaction was markedly higher than satisfaction with transport services, where 37 per cent of participants answered that they were 'Very Satisfied' (Fig. 3.16).

Fig. 3.16. Selected descriptive statistics in relation to respondents' place of residence in London



Attitudes to safety

One common factor that tends to restrict urban cycling is road safety and the perception of danger when cycling.

Photography: Robert Stainforth / Alamy

4. Mobility attitude groups: a comparative perspective

This section introduces the Berlin and London mobility attitude groups that were identified through segmentation of respondents in both cities. The segmentation was based on attitudes towards travel, the environment, technology use and residential preferences. First, the attitudinal profiles of the different groups were generated. Then, their socio-demographic, contextual and behavioural characteristics were compared to each other and between the two metropolitan regions.

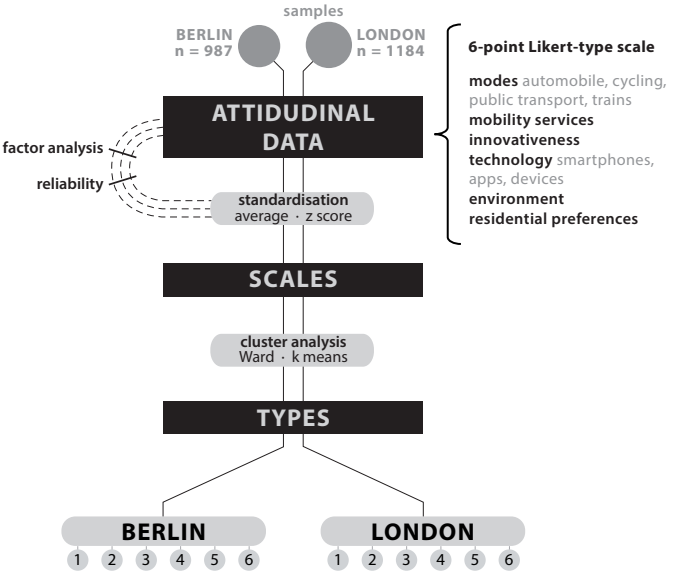
Why mobility attitude groups?

The knowledge of citizens' needs is of essential importance for the development of innovative transport policy and mobility services. When considering a broad range of different citizens, diverse needs from various segments of society can be assumed. Besides external determining factors like availability of specific mode types and individual attributes (e.g. education, income), attitudes and values can be identified as key factors for travel mode choice. Although these are assessed using milieu segmentation methods (e.g. lifestyles), empirical evidence suggests that the attitude based mobility group-approach delivers more precise indices than the former: with this approach a deeper understanding of mobility preferences of specific target groups can be achieved. Hence, suggestions for the design and communication of innovative mobility policy and products can be generated.

What are mobility attitude groups?

The concept originates from customer segmentation in market research and has been used in lifestyle research in applied sociology. A number of studies suggest it is useful in studies of mobility attitudes. Examples of such attitudes are the acceptance of rail-services or the enjoyment of car driving. Furthermore, attitudes towards innovations in the mobility sector or environmental sensibility are considered. Differentiated mobility groups are being constructed based on these attitudes, e.g. the car-oriented or the pragmatic transit users.

Fig. 4.1. Design of segmentation study

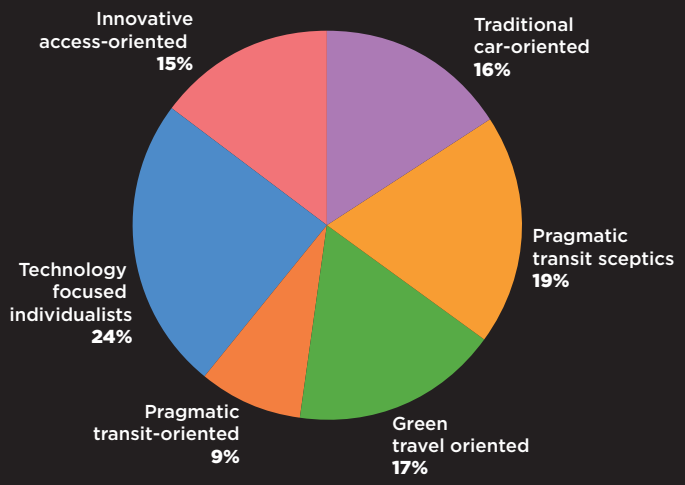


A typology of urban travellers based on their attitudes was created (see flow chart of research design in Fig. 4.1). The questionnaire generated 63 items on various attitudinal dimensions, including driving, cycling, public transport use, the use of mobility services and technology, the importance of the environment, and general statements revealing travel competence and interest in mobility. Principal component analyses (PCA) with Varimax rotation were conducted on these items separately for the Berlin and London sample in order to construct the scales for subsequent segmentation (see appendix for more details). Some scales did not show sufficient statistical consistency and were excluded. The sample was segmented using a combination of hierarchical and machine-learning (k means) cluster algorithms.

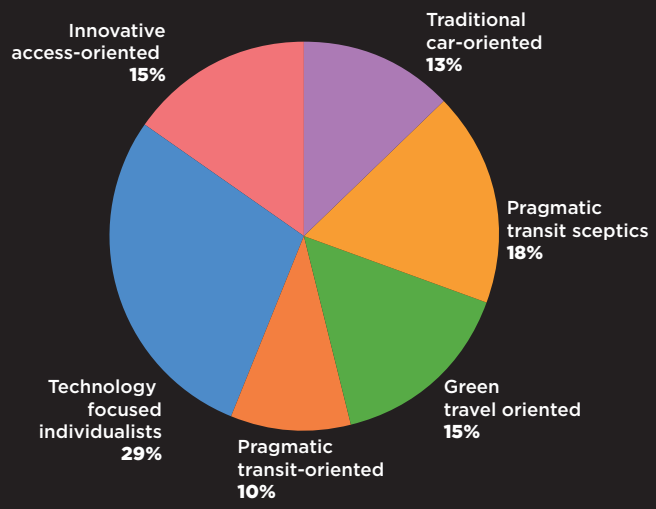
Six distinct mobility attitude groups were identified in each metropolitan region. A closer look at their attitudinal profiles revealed a high degree of similarity across the cities. Each group could also be matched to an equivalent group in the other city.

Fig. 4.2. The six mobility attitude groups in Berlin and London

Berlin



London

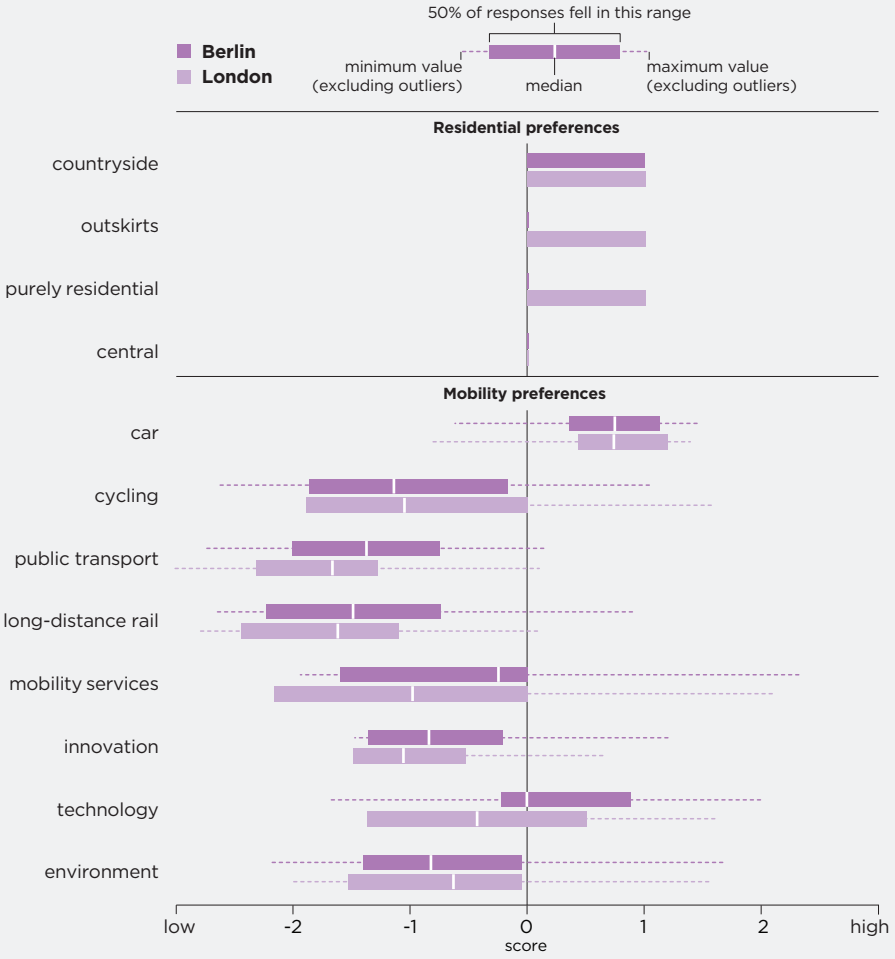


Traditional car-oriented (1)

Attitudinal profile

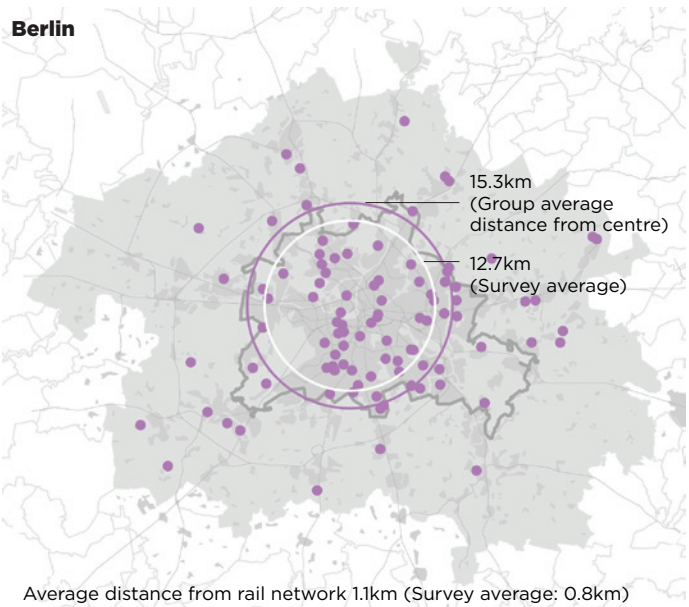
Among respondents of this group, driving is the preferred mode. There is little desire to use other modes or technology. Driving is considered to be the best way to travel and car journeys tend to be accompanied with an experience of pleasure. All other modes are rejected, implicitly, as impractical or uncomfortable. Respondents of this group prefer living on the outskirts of the city or in the countryside. They are less inclined to use technology and to be innovative in travelling.

Box plot 1: Traditional car oriented



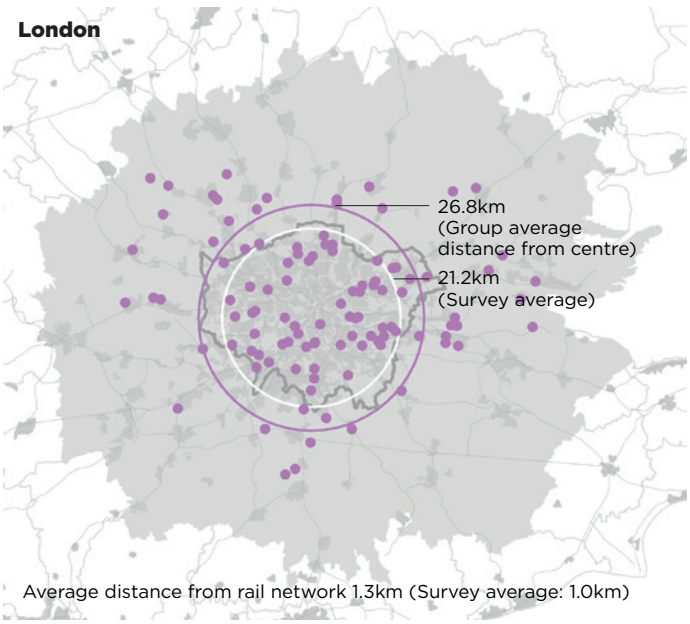
Residential location

Berlin



Average distance from rail network 1.1km (Survey average: 0.8km)

London



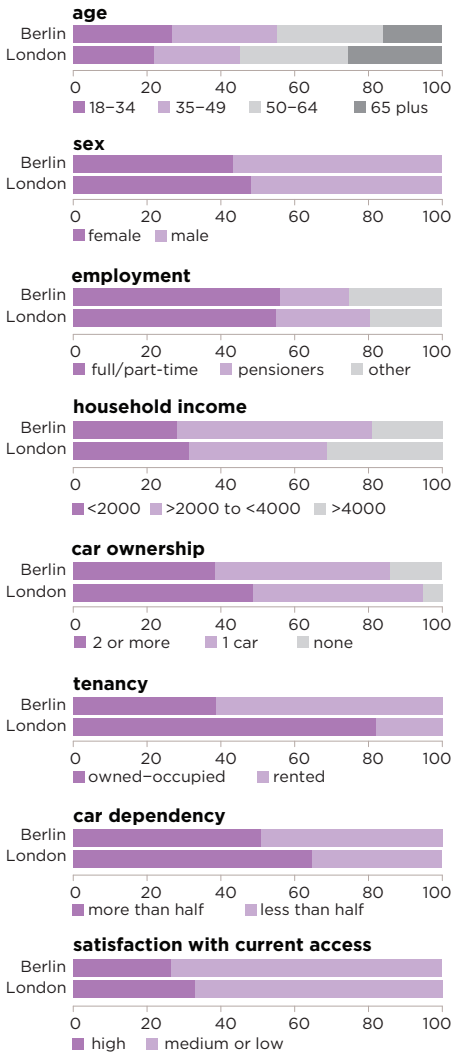
Average distance from rail network 1.3km (Survey average: 1.0km)

Contextual characteristics

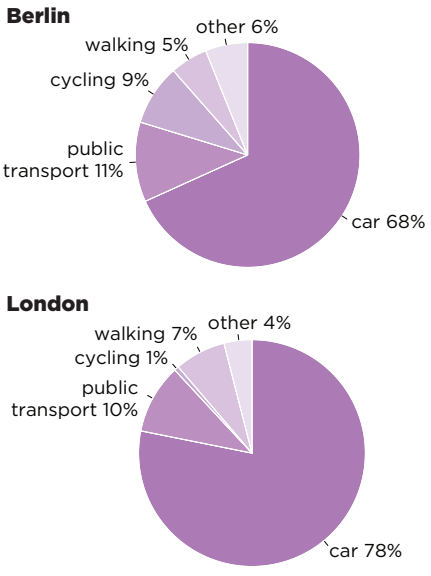
The *traditional car-oriented* are comparatively older. More than half are in full-time or part-time employment and household income is medium to high in comparison to other groups.

Traditional car-oriented respondents live significantly further away from the city centre. They are the most likely to own their homes and are also the most satisfied with their current residence compared to other groups.

The group has the highest share of driver's licences of all the groups. More than 90 per cent have licences. Around 90 per cent have access to one or more cars and the vast majority use a car for their main trips: nearly 70 per cent in Berlin and nearly 80 per cent in London. Only 10 per cent of main trips are made by public transport. The majority also report that they need a car for half of their trips or more, indicating high car dependency. Supported by their inclination to drive, this group has chosen to live in locations that allow them to execute their suburban residential preferences.

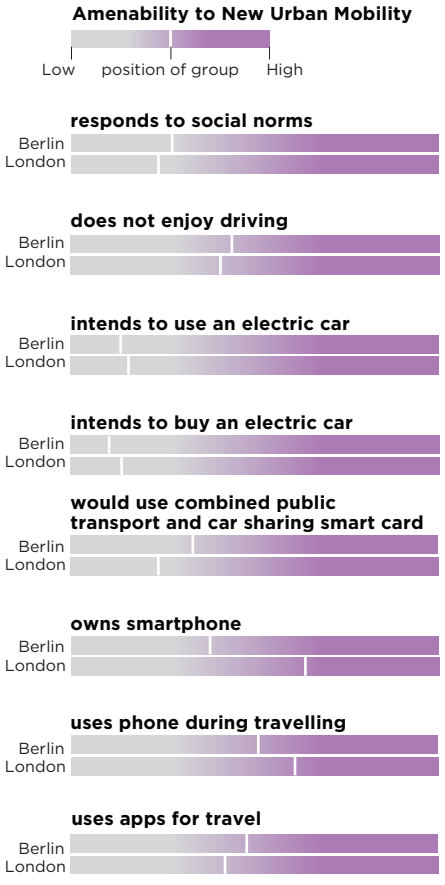


Main mode



Amenability to New Urban Mobility

The *traditional car-oriented* respond weakly to the construct of social norm, i.e. they do not rate highly the importance of what friends or relatives think about their travel behaviour. The construct correlates closely with the perceived importance of environmental protection. Members of this group are generally averse to electric car use. Only a small percentage intended to buy an electric car within the next six to twelve months. While smartphone ownership is at average levels in relation to the survey as a whole, the *traditional car-oriented* tend to access the Internet on their phones on a daily basis, but, on average, only use travel apps a few times per month.

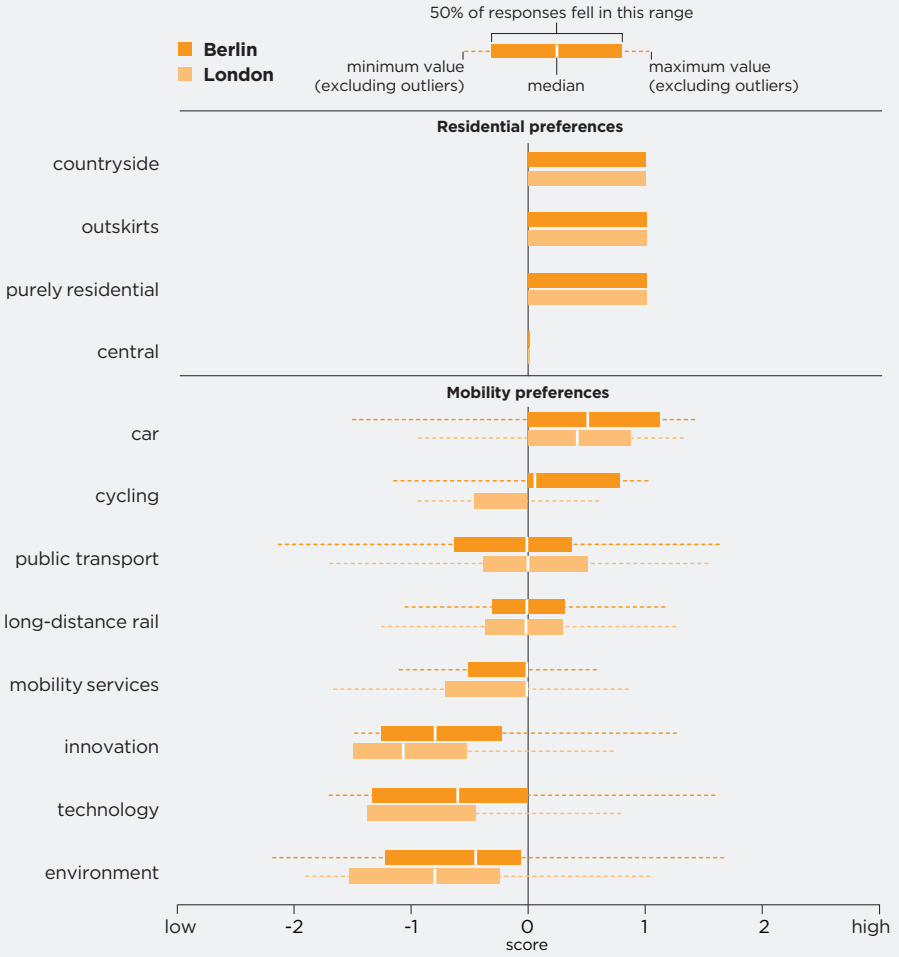


Pragmatic transit sceptics (2)

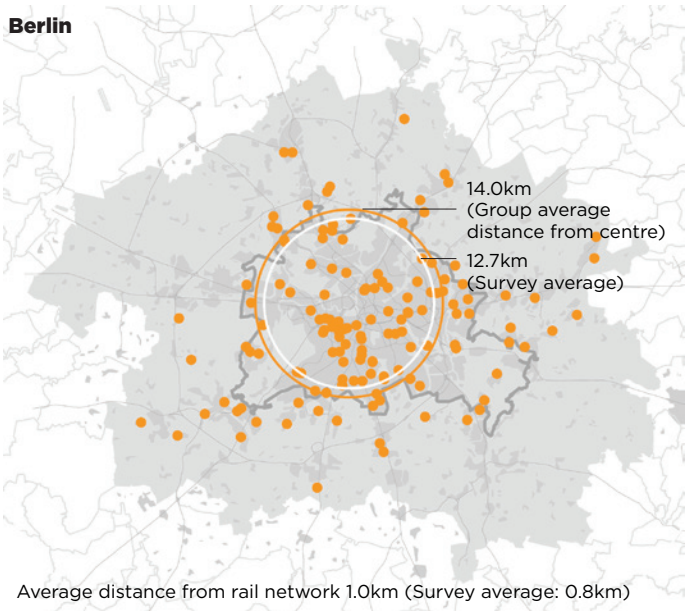
Attitudinal profile

This group is comprised of individuals who prefer car use but show diverse tendencies with respect to other modes. They dislike technology and tend not to be innovative in travel. In London, this is the segment with the least favourable attitudes towards digital technology. In Berlin these individuals enjoy driving, but at the same time they are more open to cycling than their equivalent group in London.

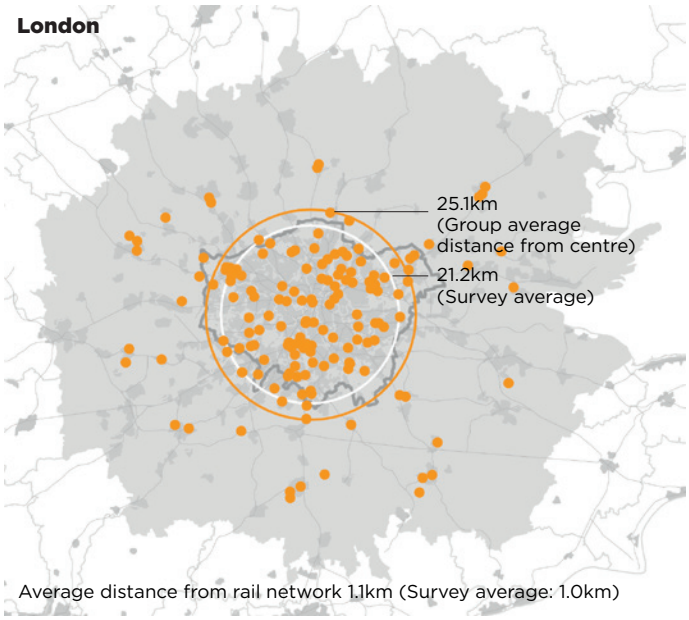
Box plot 2: Pragmatic transit-sceptics



Residential location



Average distance from rail network 1.0km (Survey average: 0.8km)

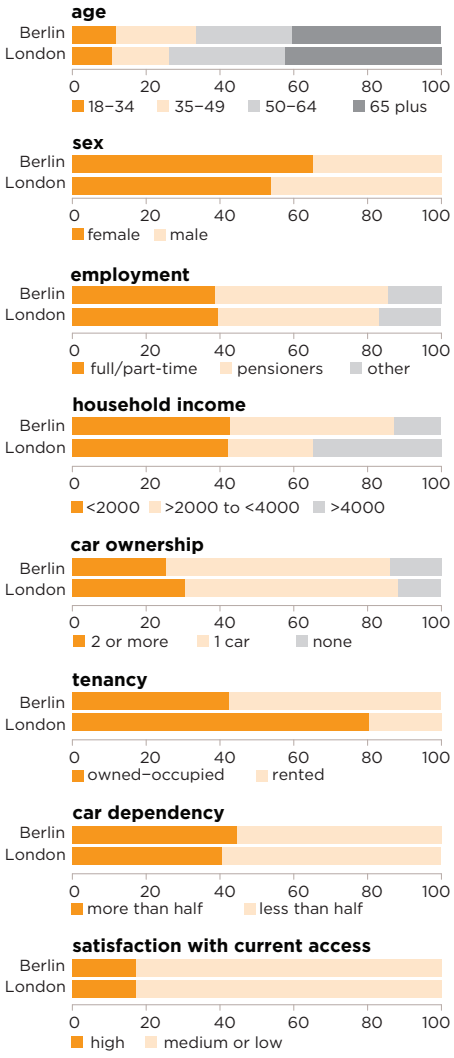


Average distance from rail network 1.1km (Survey average: 1.0km)

Contextual characteristics

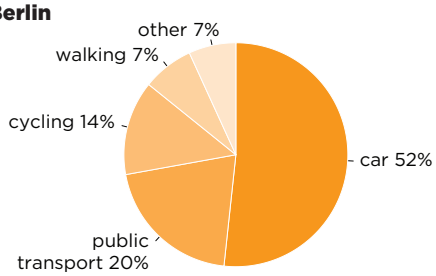
In both cities, *pragmatic transit sceptics* have the oldest average age among all groups. This is reflected in the share of pensioners: more than 40 per cent. They live in both central and suburban areas. In Berlin, they have the highest home ownership rates (43 per cent).

More than 80 per cent have a driver's licence and nearly 90 per cent have access to a car. More than half report that the car is their main mode and more than 20 per cent use public transport for their main trips, which reflects their strong preference for car travel even though they remain open to other modes. In Berlin, 14 per cent cycle – indicating that cycling could be an alternative for this group in London, too, if cycling became more established. They have the second highest car dependency, with more than 40 per cent indicating that they need a car to complete at least half of their daily travel. While the car is generally preferred, this group is open to choosing other modes if they appear more convenient.

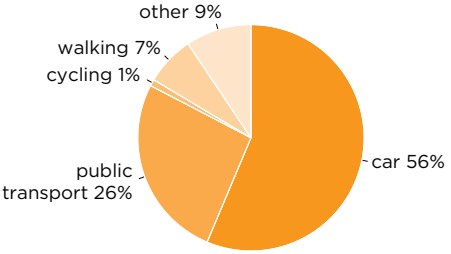


Main mode

Berlin

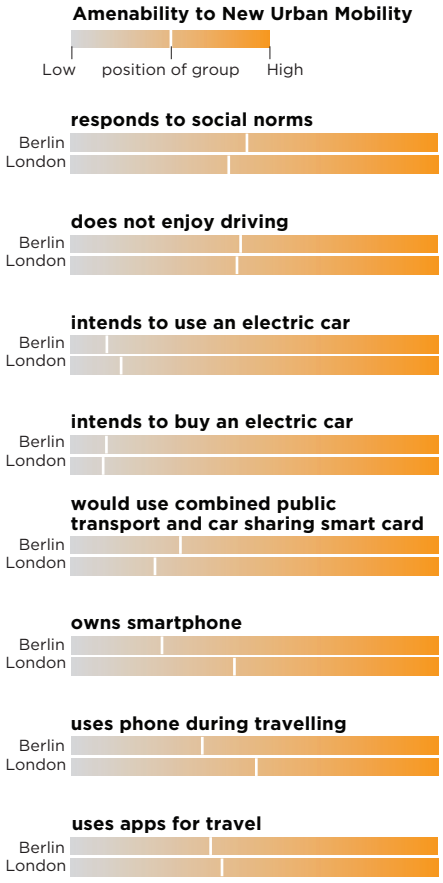


London



Amenability to New Urban Mobility

The *pragmatic transit sceptics* show a weak response to the social norm construct. Members of this group show the same level of hesitation towards electric cars and smart cars as the *traditional car-oriented* group. Smartphone ownership rates are among the lowest in both cities. Smartphone owners in this group tend to use the Internet on their phones weekly or less often. Travel apps are used less frequently at only once per month on average.

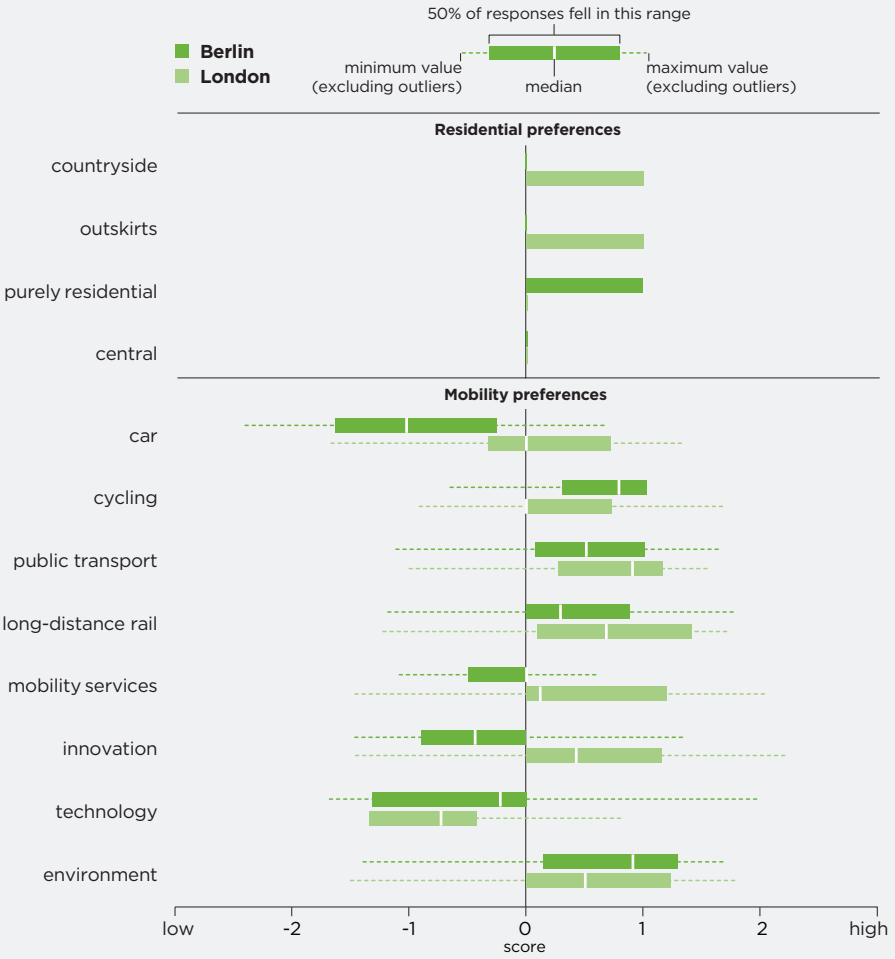


Green travel oriented (3)

Attitudinal profile

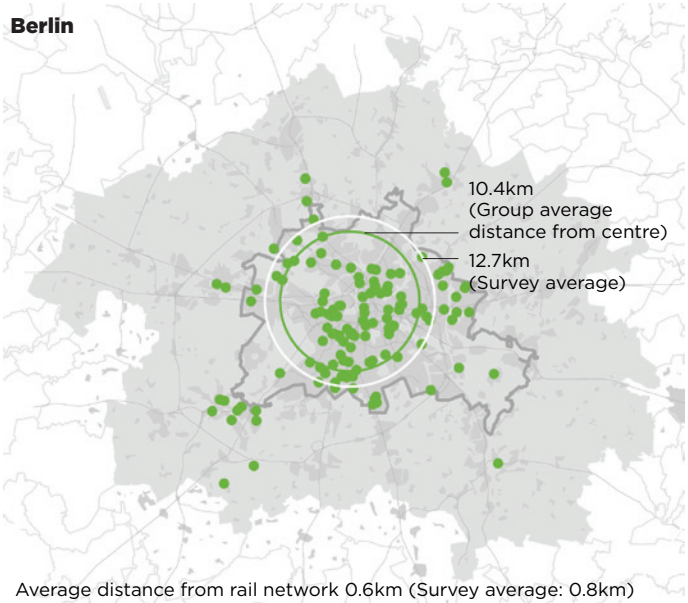
Green travel oriented stand out because individuals attach a lot of importance to environmental protection. They positively rate public transport, including travel by train over long distances. They tend to dislike the use of digital technology. In London, this is the segment that most favours public transport; however, they do not disapprove of cars as much as they do in Berlin. There, respondents show the strongest rejection of driving compared to other groups in Berlin, as well as the strongest approval of cycling. Members of the London group are more innovative in their travel and more inclined to use alternative mobility services, such as car sharing, online services to book tickets or share bicycles.

Box plot 3: Green travel oriented



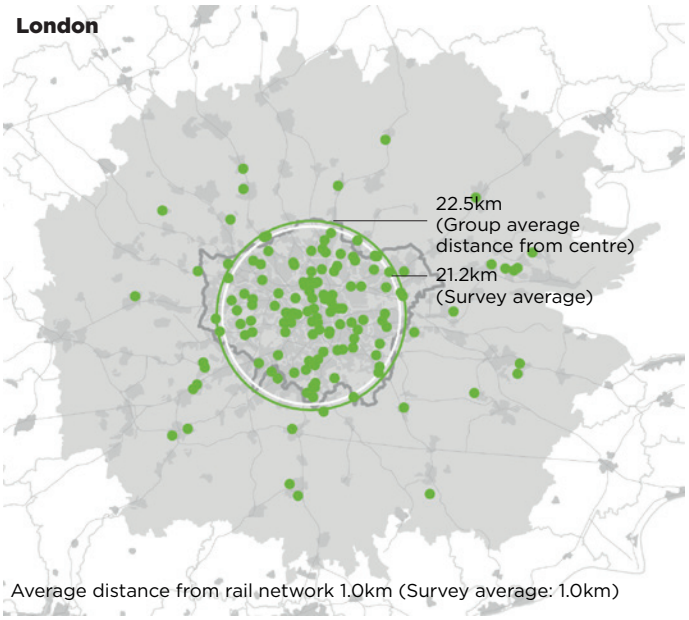
Residential location

Berlin



Average distance from rail network 0.6km (Survey average: 0.8km)

London



Average distance from rail network 1.0km (Survey average: 1.0km)

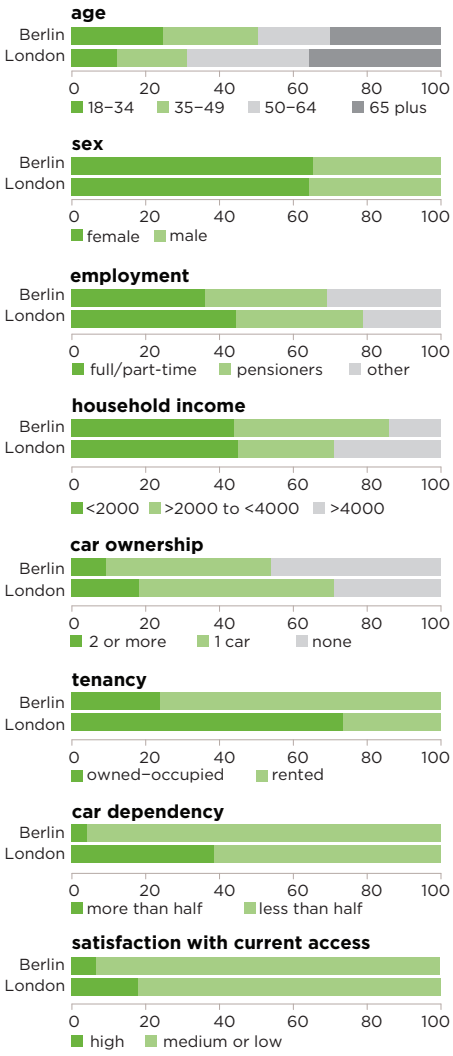
Contextual characteristics

In both cities, they are the group with the highest proportion of women (65%). They earn lower incomes compared to other groups; yet in Berlin, they are the group with the highest share of university degree holders.

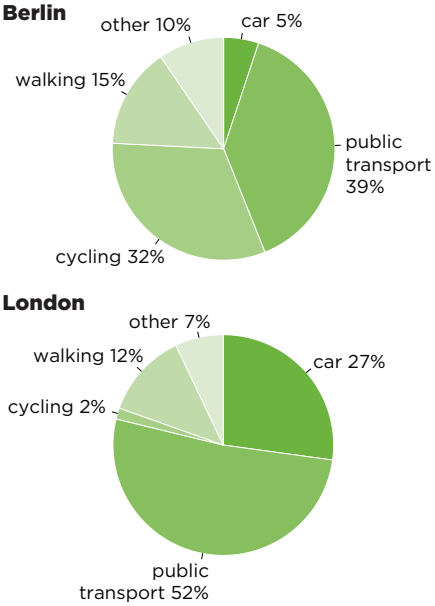
Green travel oriented are more concentrated in the metropolitan centres or sub-centres that are accessible by rail. In Berlin, the rate of satisfaction with their current residential situation is lowest (7%); not so in London, where more than 18 per cent report high levels of satisfaction. This may also be linked to different home ownership rates: home ownership rates are far lower in Berlin than in London.

The share of driver's licence holders is approximately 65 per cent, which is lower than other groups. In Berlin, just over half have access to a car; in London this share is above 70 per cent. Public transport is the most popular mode in both cities, with 39 per cent in Berlin and more than half in London. In Berlin, however, nearly one third of respondents reported that they cycle for their main trips. In the London group, the proportion of cyclists is just under two per cent.

With respect to car use, the two groups differ between cities. In Berlin, five per cent use cars frequently; median vehicle kilometres per year is only 2,600 km. Only five per cent indicate that at least half of their daily travel would not be possible without their car. In London, car use among this group is higher: 27 per cent use the car as main mode, they travel 6,400 kilometres per year and their car dependency rate is 39 per cent.

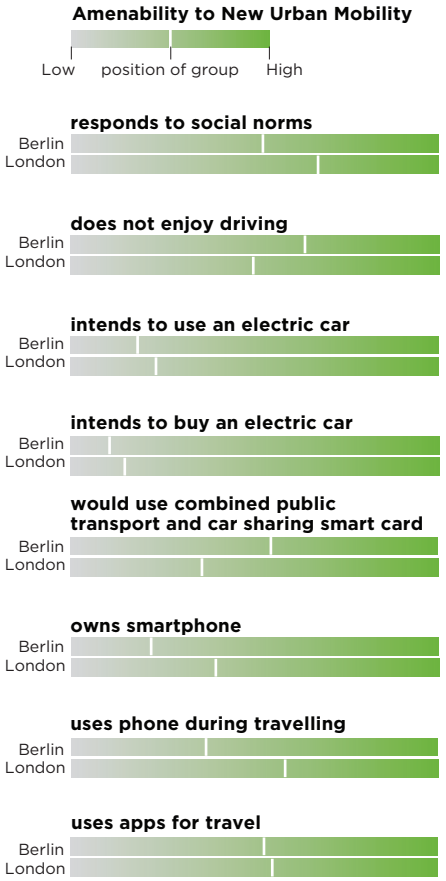


Main mode



Amenability to New Urban Mobility

Social norms play a bigger part in the orientations of London *green travel oriented* than in the Berlin counterpart, despite their similar pro-environment attitudes. Consistent with their attitudes and behaviour, they show high preference for public transport and little preference for car use. Members of this group are sceptical of the idea of a combined car hire and public transport smart card; however, Berlin respondents seem more open to the idea. While smartphone owners use their phones several times per week to access the Internet, travel apps are only used a few times per month. Particularly in Berlin, technology does not play a strong part in this group's daily mobility.

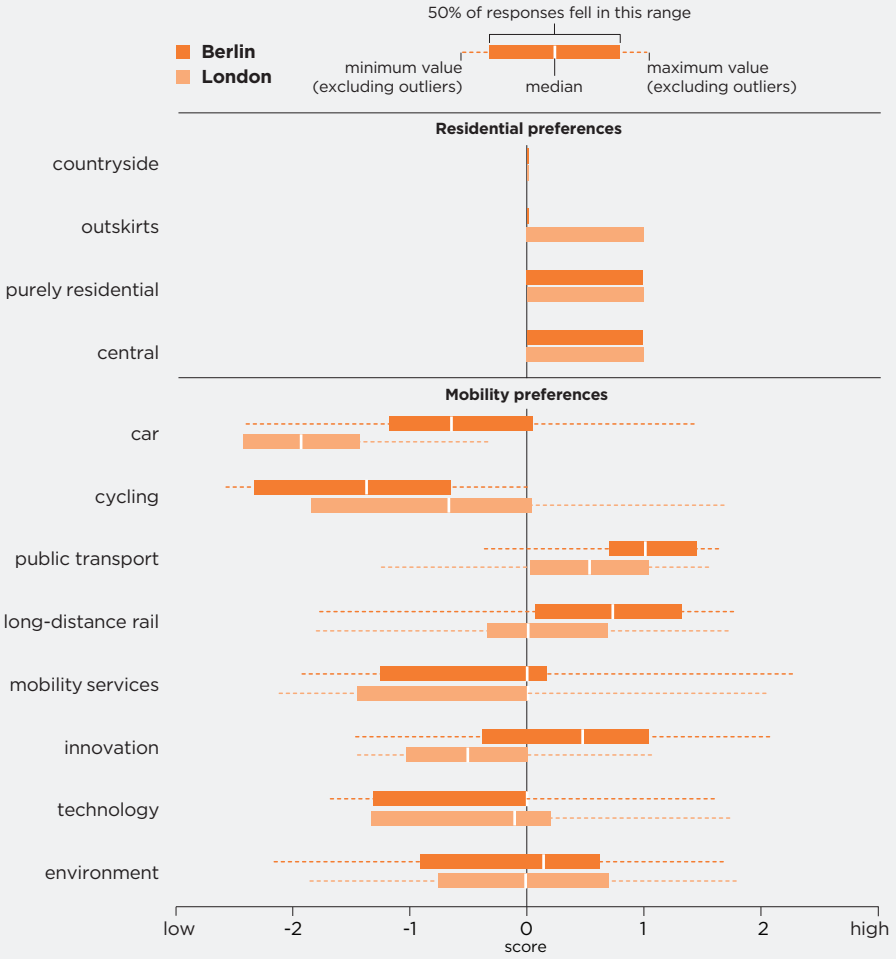


Pragmatic transit-oriented (4)

Attitudinal profile

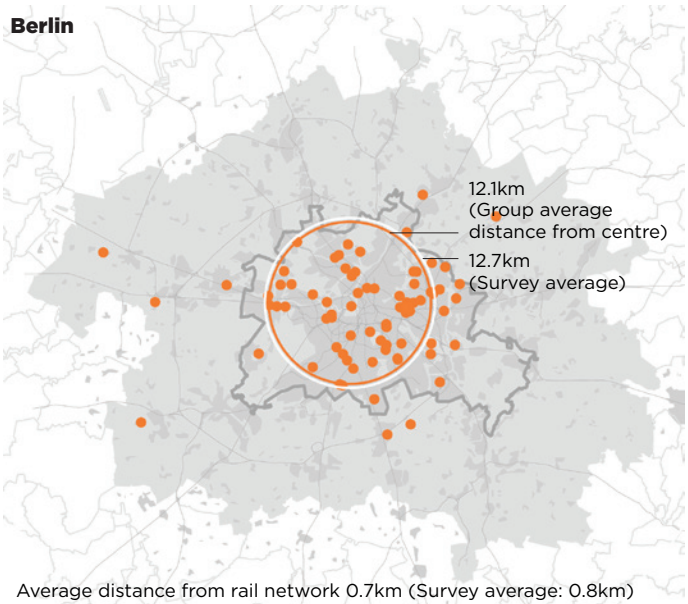
Pragmatic transit-oriented comprise individuals that positively rate various aspects of public transport use but negatively rate the use of technology. They differ from *green travel oriented* in that environmental protection is not considered to be as important. Again there is a Berlin-London split with regards to innovation: this time, the group in Berlin is more innovative than the London group. In both cities, the *pragmatic transit-oriented* group prefers central urban locations over the countryside.

Box plot 4: Pragmatic transit-oriented



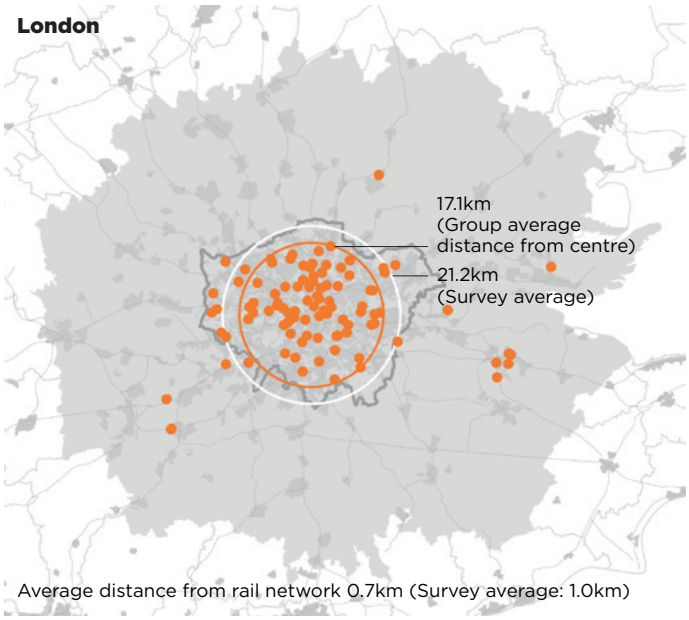
Residential location

Berlin



Average distance from rail network 0.7km (Survey average: 0.8km)

London



Average distance from rail network 0.7km (Survey average: 1.0km)

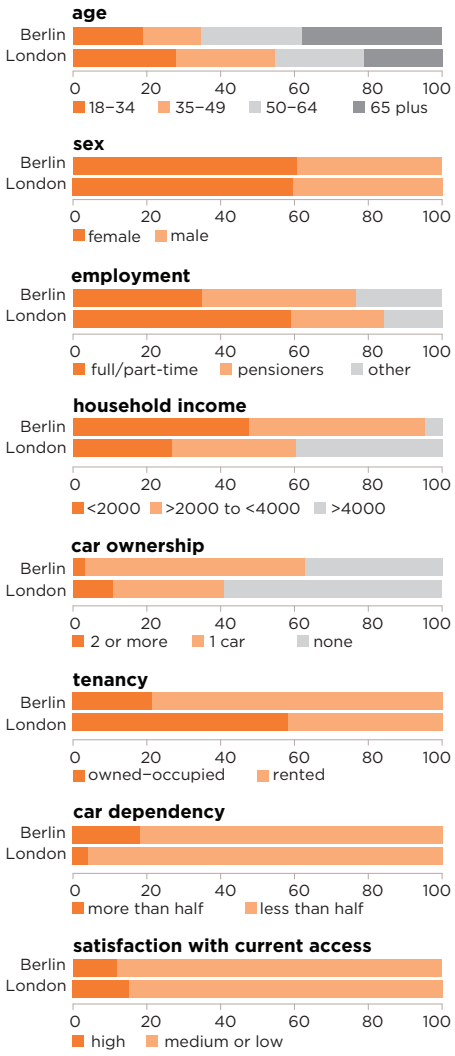
Contextual characteristics

Pragmatic transit-oriented individuals are on average 51 and 57 years old in Berlin and London respectively. The proportion of women (around 60 per cent) is higher than other groups. The share of low income earners is higher in Berlin; in London the majority earn higher incomes. In Berlin, they also have the lowest share of university degree holders (28 per cent). In London, it is generally higher (60 per cent) than other groups.

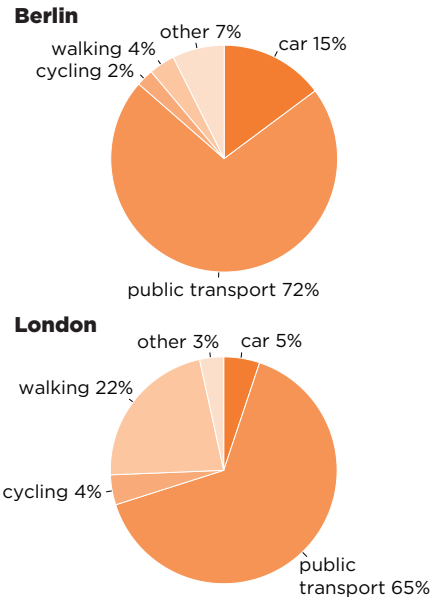
Pragmatic transit-oriented are concentrated in the centre of both metropolitan regions, where public transport accessibility is higher. Compared to other groups, satisfaction levels with their current residential situation is lower. Only one in five in Berlin is an owner-occupier compared to three in five in London. In both contexts, this indicates low ownership rates.

The share of driver's licence holders is low. In London, it is 44 per cent which is considerably lower than other groups. In Berlin, the share of 63 per cent car ownership rates are similarly low. The vast majority (70 per cent) of *pragmatic transit-oriented* use public transport as their main mode. This is consistent with their strong attitudinal orientation towards public transport. In Berlin, only 2.5 per cent cycle to complete their main trips – the lowest share among all Berlin groups.

Only five per cent of the London group take a car as their main mode, compared to 15 per cent in Berlin. 22 per cent of the London group walk as their main mode. This makes it the greenest modal split found in London: 92 per cent walk, cycle or take public transport – and this cannot be explained by their pro-environmental attitudes. Location and transport access seem to make this combination the best way of travelling.

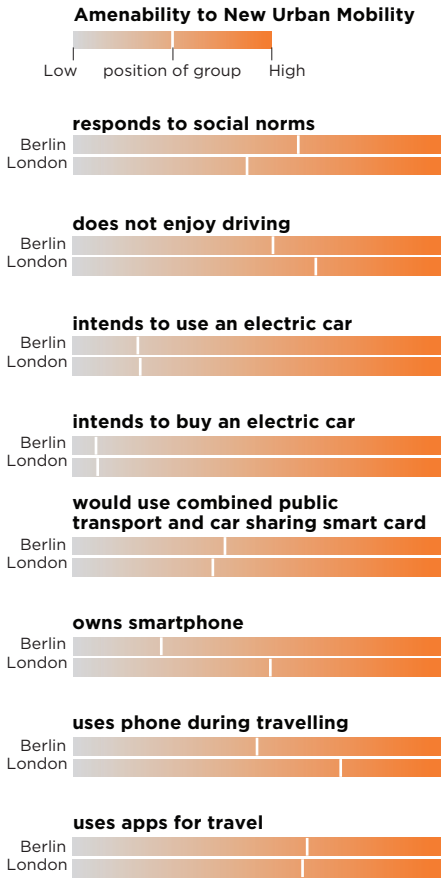


Main mode



Amenability to New Urban Mobility

Social norms are important in the orientations of Berlin *pragmatic transit-oriented* but less so in the London equivalent. In both cities, the majority indicate strong preference for public transport. Intentions to use electric cars are weak in this group; only a minority are willing to hire or buy electric cars. This may be related to their general disapproval of cars. The level of approval of combined smart cards is higher than for car-oriented groups. Smartphone ownership is low but, if a smartphone is owned, the use of travel apps and their phone is above average in comparison to other groups. As they use public transport more often, this seems to allow more opportunities for mobile phone use while on the move.

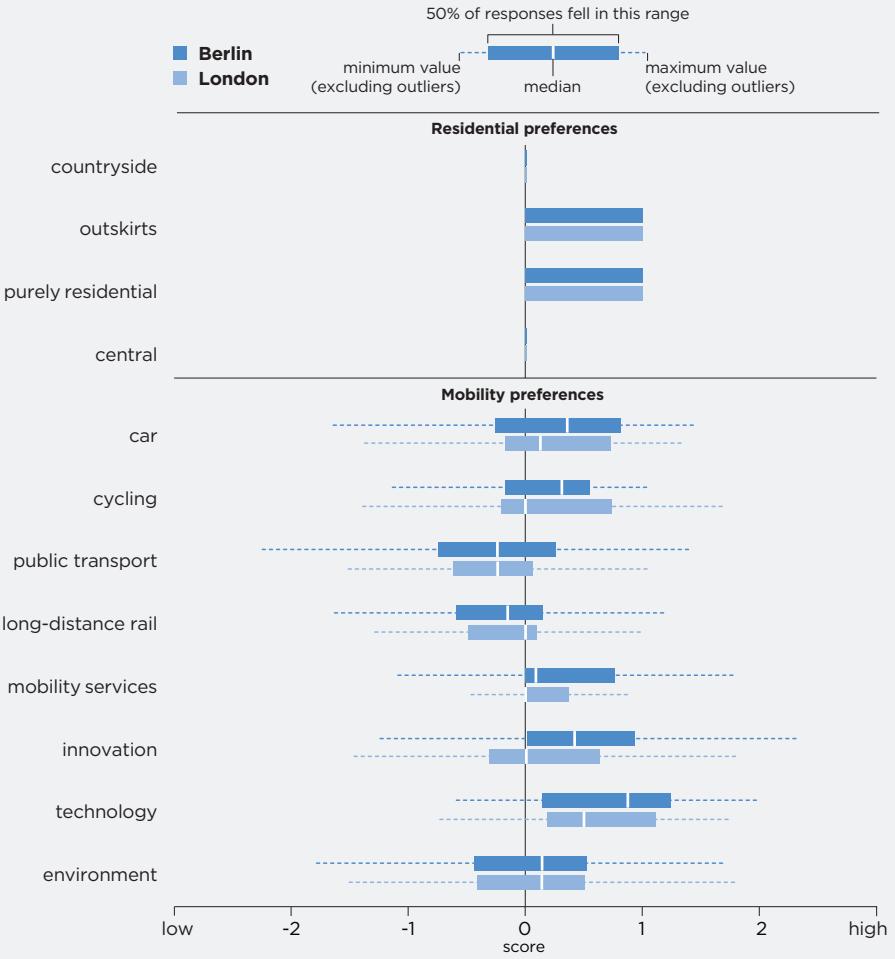


Technology focused individualists (5)

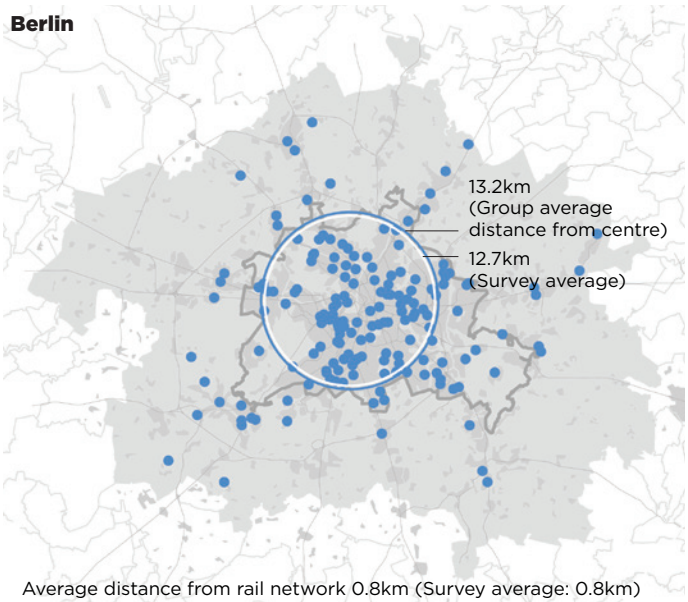
Attitudinal profile

Technology focused individualists feel positive about the use of private modes of travel, driving and cycling, as well as technology. They dislike collective modes of travel, exhibit diverse attitudes towards mobility services and are also innovative in travel. Environmental concerns are unimportant. In both cities, *technology focused individualists* form the largest group: in Berlin 24 per cent and in London 29 per cent are classified as *technology focused individualists*. Overall, their attitudinal profile suggests a desire for autonomy.

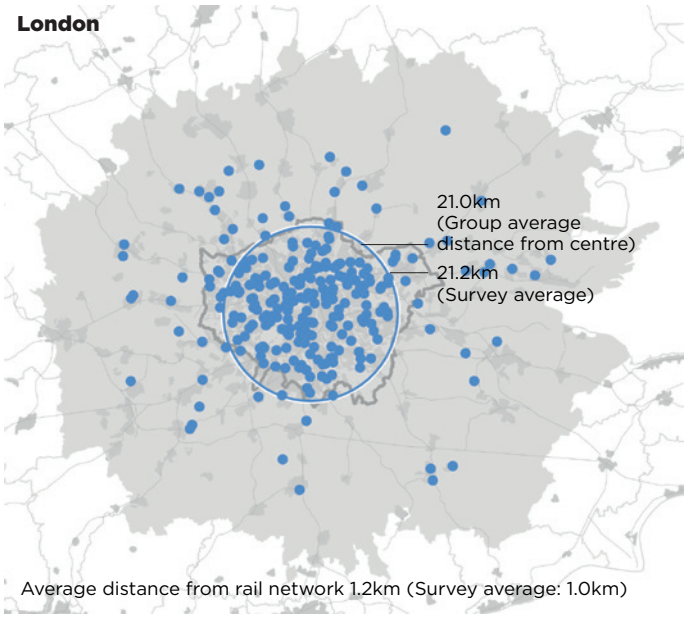
Box plot 5: Technology-focused individualists



Residential location



Average distance from rail network 0.8km (Survey average: 0.8km)



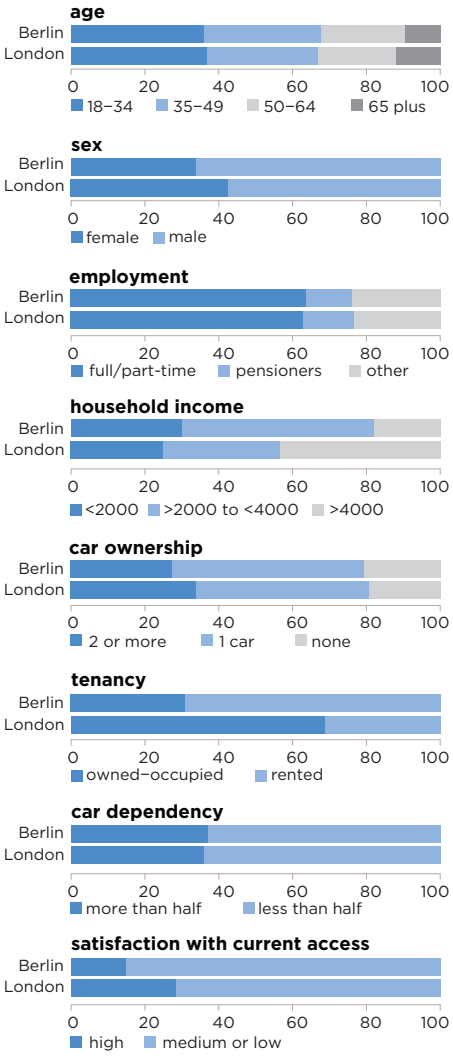
Average distance from rail network 1.2km (Survey average: 1.0km)

Contextual characteristics

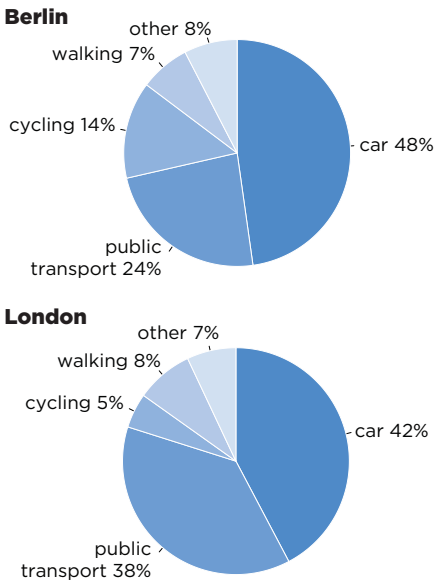
Technology focused individualists are among the youngest groups in both cities with average ages of 43 years. The majority of this group are male. They have the highest proportion of people in full or part-time employment and the share of low income earners is the smallest of all the groups. In London they have the highest proportion of university degree holders (73 per cent). In Berlin the share is lower (37 per cent) but still high relative to other groups.

Technology focused individualists live in central locations although they show a preference for living on the outskirts. Yet the level of satisfaction with the current residence tends to be higher than in other groups. Owner-occupier rates are high; in Berlin, nearly one in three own their home, in London more than two in three.

Both the share of driver's licences and car ownership rates are high, albeit not as high as in the other car-oriented groups. The car is the main travel mode: almost half of all journeys are made by car. The level of car dependency is high and this is reflected in high annual kilometres driven. This is followed by public transport at 38 per cent in London and 24 per cent in Berlin. In Berlin, however, *technology focused individualists* are more likely to cycle: 14 per cent indicate that the bicycle is their main mode of travel compared to just five per cent in London. This again points to the elevated role of cycling in Berlin.

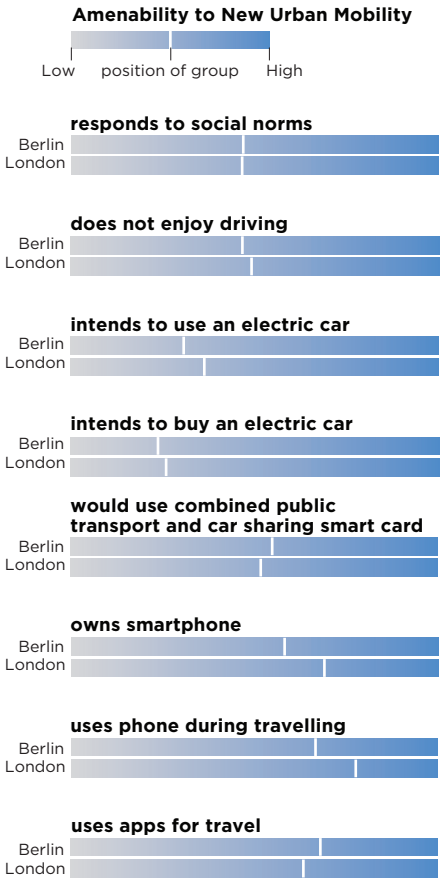


Main mode



Amenability to New Urban Mobility

While social norms are unimportant among *technology focused individualists* tend to enjoy driving, suggesting an affective orientation in mode choice. A clear majority prefers the car to other modes – only a small proportion prefer public transport. Electric vehicles are generally approved and are considered as a potential option to hire or buy. Smartphone ownership rates are high and smartphone owners use the Internet on their phones while on the move at least once per day. Travel apps are used on average several times per week. Technology, specifically ICT, seems to play a bigger part in the lives of these individuals than for other groups.

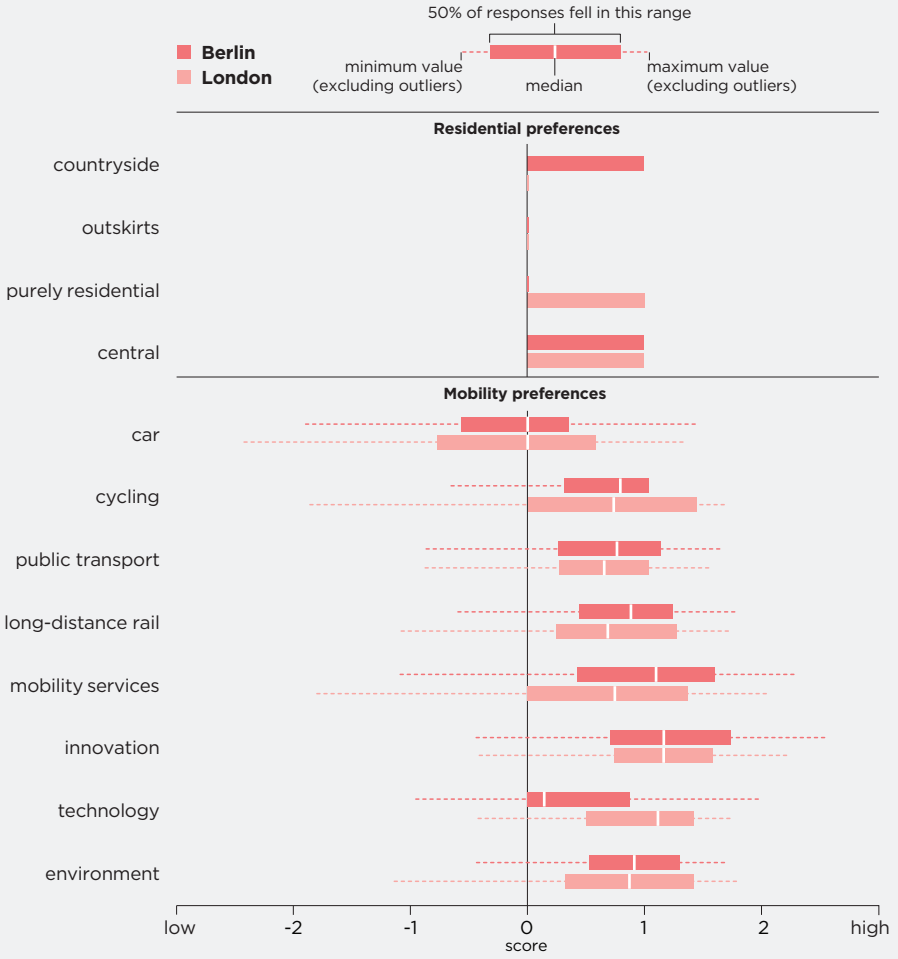


Innovative access-oriented (6)

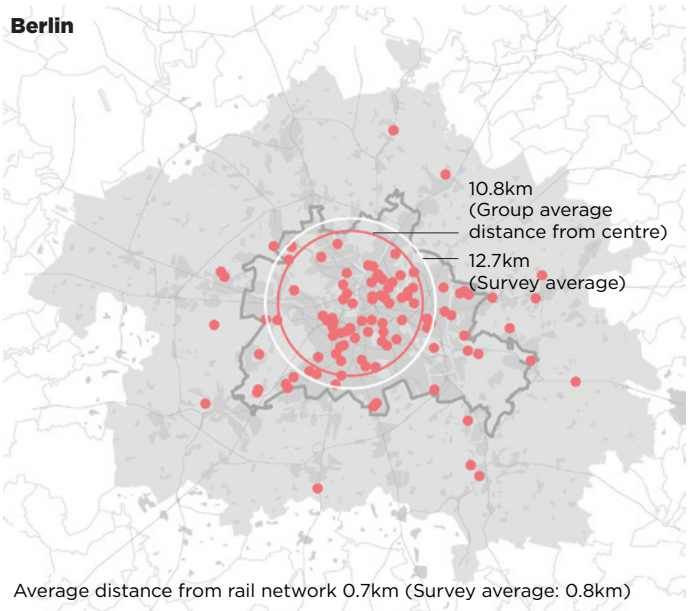
Attitudinal profile

Innovative access-oriented are amenable to use modes of travel other than the car and they are inclined to be innovative in travel. They are the most informed about latest developments in transport; they know about new products and services and enjoy trying them out. They are supportive of technology use and the protection of the environment. Their residential focus is urban, with the strongest preference for that location compared to all other groups.

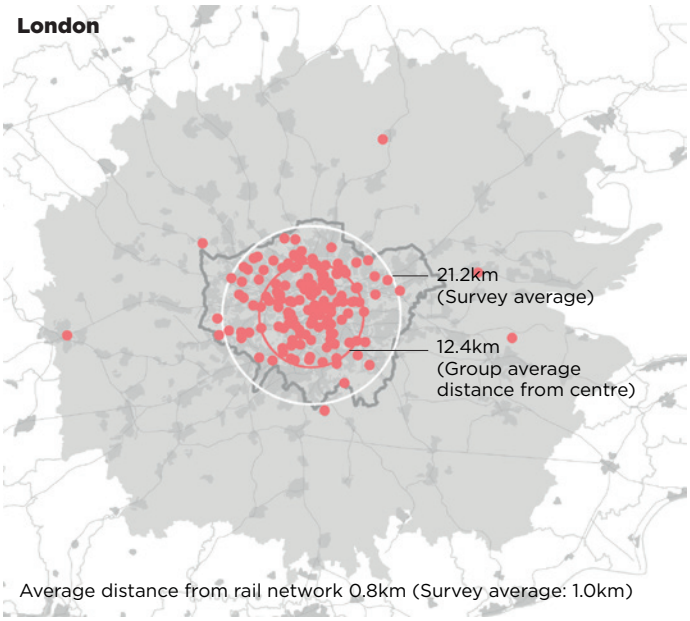
Box plot 6: Innovative access-oriented



Residential location



Average distance from rail network 0.7km (Survey average: 0.8km)



Average distance from rail network 0.8km (Survey average: 1.0km)

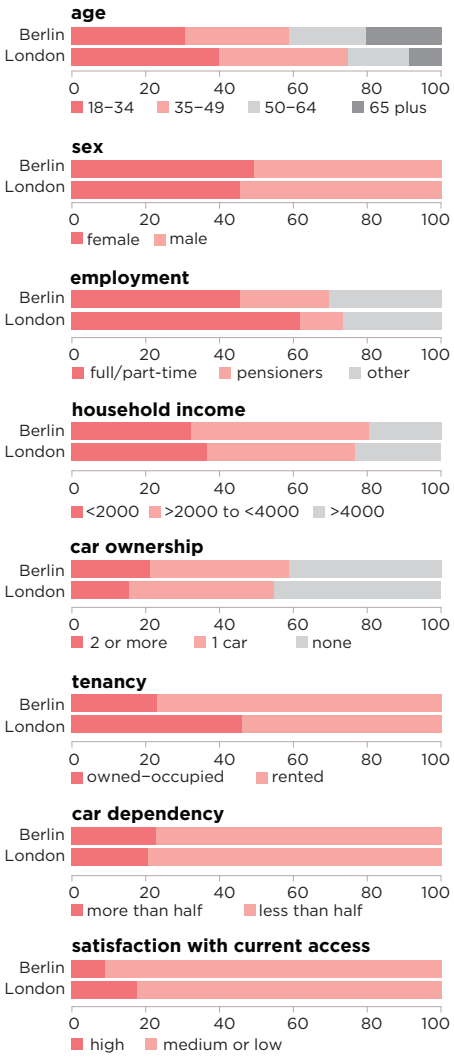
Contextual characteristics

Innovative access-oriented are among the younger groups in both cities. The share between males and females is roughly even and the majority are in full or part-time employment and earn medium to higher incomes. The share of individuals with a university degree is high in context.

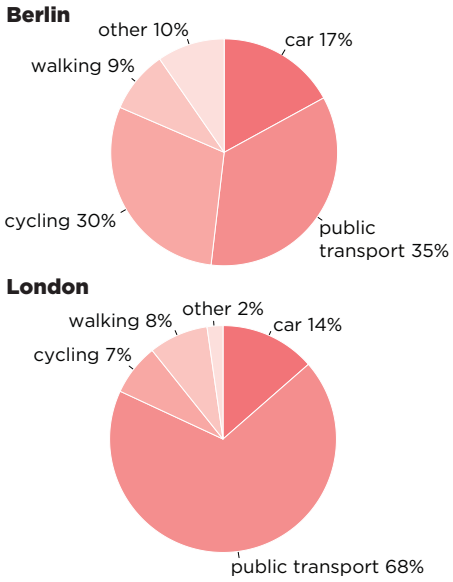
Innovative access-oriented are concentrated in central locations, which is consistent with their attitudinal profile. The levels of satisfaction with their current residence are low in comparison, however. Owner-occupier rates are also lower compared to respective national averages: in Berlin it is 23 per cent, in London 46 per cent.

Both the share of driver's licences and car ownership rates are lower in comparison. In both cities, little more than half report having access to a car. Only 17 per cent in Berlin and 14 per cent in London use cars as their main mode. The most common transport mode is public transport. In London, nearly 70 per cent travel by public transport for their main trips. In Berlin it is just 35 per cent, but this is closely followed by cycling at 30 per cent. This makes this group, together with *green travel oriented,* the most cycling-focused group. In London, seven per cent of *innovative access-oriented* cycle, which is more than any other group.

While one in five *innovative access-oriented* report high car dependency, the lower level of car use translates into low annual vehicle kilometres travelled.

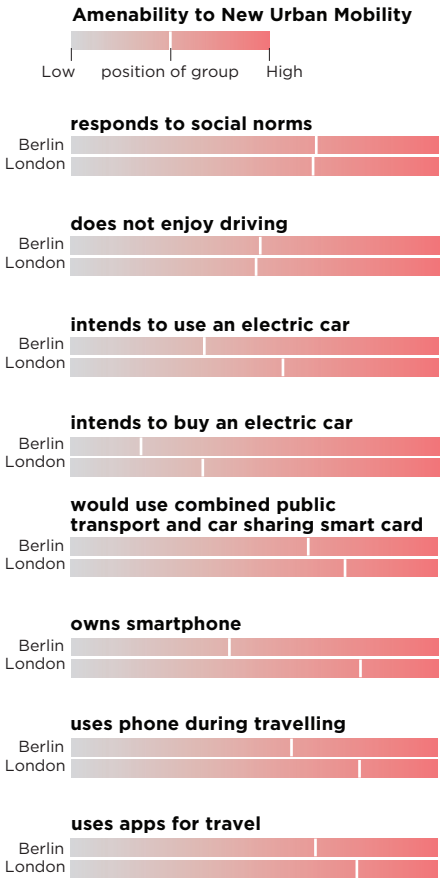


Main mode



Amenability to New Urban Mobility

Innovative access-oriented care about what others think about their choices, scoring high on the social norm scale. While they tend to disapprove of cars, there are city-specific differences with respect to the other modes: in Berlin, 43 per cent prefer bicycles to all other modes and 30 per cent public transport; in London, 60 per cent prefer public transport and 11 per cent cycling. In both cities, this group shows the strongest approval of electric vehicles as well as willingness to hire and buy them. They also welcome the idea of combined car hire and public transport smart cards. Smartphone ownership is high and travel apps are accessed several times per week.



5. Policy implications

This page summarises policy priorities and options for targeting each attitude group. In addition to group-specific measures, the common trends suggest policy should provide an overall framework for alternative mobility: limiting of parking spaces, affordability and feasibility of multi-modal travel are among the most effective policies to support change towards sustainable travel.

Traditional car-oriented (1)

policy goal: mitigate and compensate
- compensate for environmental impact
- reduce environmental impact
- reduce driving and car ownership where possible

potential alternatives
- electric cars

policy options
- congestion charging
- parking fees
- low emission zones
- tax benefits upon purchase of low emission vehicles

The policy priority for this group is first to compensate for the environmental impact of their travel, second to mitigate their impact and third, to reduce driving and car ownership where possible. As this type will strongly resist mode-switching, fiscal policy mechanisms (e.g. congestion charging, parking fees) should be employed to leverage funds for compensatory environmental improvements. In terms of mitigation, the main focus should be on encouraging the use of low emission vehicles, which may partially be achieved through further fiscal incentives (i.e. tax benefits upon purchase of low emission vehicles). Extra charges or banning high emission vehicles in city centres may be necessary to mitigate the environmental impact of this group. A weaker intervention would be to provide guidance on eco-driving.

Pragmatic transit sceptics (2)

policy goal: mitigate
- reduce environmental impact
- reduce driving and car ownership where possible

potential alternatives
- electric cars
- car sharing
- cycling (Berlin)
- public transport (London)

policy options
- free testing of electric cars and car sharing schemes
- promote flexible car sharing schemes
- tax benefits upon purchase of electric cars
- congestion charging
- Berlin: promote cycling
- London: promote public transport use, e.g. through special fares, free travel pass for trial period

Although this group show diverse attitudes towards modes other than the car, their strong rejection of technology inhibits access to alternative mobility services and multi-modal travel. Other demographic and behavioural characteristics indicate this group have firm travel habits linked to long-standing car ownership with little openness to change. Therefore interventions should aim at reducing the environmental impact of these habits by improving access to electric cars, wherever feasible. Given the pragmatic orientation of this group, promotions that allow users to temporarily test alternative modes (electric cars, car sharing, public transport) for free may be most effective in highlighting aspects of feasibility and convenience, and encouraging increased use of low emission travel. These interventions may be even more successful in combination with fiscal policy instruments to reduce high car ownership rates while leveraging greater openness towards other modes to sustainably alter mobility practices.

Green travel oriented (3)

policy goal: affirm and encourage
- maintain and expand cycling and public transport use
- London: reduce car use and ownership further

potential alternatives
- walking
- cycling
- public transport

policy options
- regular information on local travel and mobility options
- promote mobility services to improve travel experience, particularly online services
- target with specific offers to trial new services
- promote use of technology in travel

This group already show a predisposition towards more sustainable travel. The major policy objective should be to help these individuals maintain their level of cycling and public transport use, in particular when life circumstances change; having children or relocation may induce a reorientation in travel behaviour. In this case, information about mobility services that support flexible travel need to be made available, for example, in welcome packs for new residents with specific information about safe and independent travel. It may also be worth introducing strategies to increase openness towards technology use and innovation.

Pragmatic transit-oriented (4)

policy goal: affirm and encourage
- maintain and further encourage cycling and public transport use
- Berlin: reduce car use and ownership further

potential alternatives
- public transport
- cycling, bike-and-ride
- car sharing

policy options
- sustain positive public transport experience
- target with specific offers to trial new services
- affordable public transport
- encourage technology use

The major policy objective for this group should be to support maintenance and extension of current travel habits. Although general campaigns increasing environmental and moral consciousness may be useful in targeting this group, moral appeals may not be effective in preventing driving at a later life stage. The emphasis should therefore be on policy options that highlight aspects of feasibility and convenience of alternative modes, notably car sharing. Their general preference for living centrally, low car ownership rates and existing experience with collective modes provide favourable ground for these interventions.

Technology focused individualists (5)

policy goal: switch
- reduce driving and car ownership
- reduce environmental impact

potential alternatives
- cycling
- electric cars
- car sharing

policy options
- highlight autonomy and fun aspects of alternatives, including public transport modes
- target through technology channels, smartphone travel apps and electronic services
- encourage cycling through campaigns highlighting personal benefits (health, fitness, fun)

This group favour private modes of travel and use of digital technology framed by a desire for autonomy. The policy priority should be to reduce driving and car ownership. Interventions should aim at highlighting the flexibility, individuality and enjoyment alternative modes provide, communicating how easy it is to combine public transport with car sharing or cycling across the metropolitan region. This may be best achieved through programmes that allow this group to test alternatives and discover the pleasure of using travel apps and real time online services in a smart and creative way while also enjoying health and fitness benefits. Rapid access to information and the innovative use of new information technology as a channel for durable interventions are crucial to reach this group.

Innovative access-oriented (6)

policy goal: inform and encourage
- encourage further use of alternative modes
- further reduce car use

potential alternatives
- walking
- cycling
- public transport
- electric car hire

policy options
- promote mobility services to improve travel experience, particularly online services
- inform instantly about new options and services

Policy objectives should focus on encouraging further uptake of alternative modes and reduction of car ownership and driving. Innovative access-oriented are inclined – due to their curiosity and confidence in travel – to try new modes and services. The most effective policy option may therefore be to keep this group informed about latest developments in transport options and mobility services in their area and within the city. ICT is an effective channel for interventions given the high rate of smartphone ownership and use of mobile applications during travel. Electric car sharing may be a reasonable alternative to car ownership, when life circumstances change. Information tools facilitating the use of this service may be effective in consolidating the sustainable profile of this group.

6. Conclusion

This study confirms that attitude-based mobility groups are useful in characterising the subjective dimensions of travel behaviour and the wider choices affecting urban travel. The study suggests that neither the socio-demographic aspects of residents nor travel behaviour alone are sufficient to develop effective policy interventions. Differences in socio-demographic characteristics, travel behaviour and residential location among groups are considerable and may appear contradictory if viewed in isolation and without an attitudinal dimension. For example, the relatively low car ownership rate and infrequent car use among *innovative access-oriented* respondents (group 6), who comprise young families with higher incomes, would be surprising if they had not been identified as innovative and flexible through their attitudinal profile.

Similarly, high car ownership rates among *technology focused individualists* (group 5) would not suggest the high uptake of cycling that we can observe in Berlin. The fact that one in five members of this group cycle in Berlin may suggest that the London equivalent would cycle too if cycling conditions were more conducive. Here, the comparative method of this study suggested an important potential for change within a car-orientated group that would have otherwise remained hidden.

Across all groups the relationship between attitudinal profiles, travel behaviour and long-term mobility choices (residential location, car ownership) correspond strongly. From these findings, one cannot reject the existence of multi-directional causal relationships between context, individual preferences and travel choices. Attitudes towards travel are shaped by context but, at the same time, attitudes towards travel drive residential decisions and confine behavioural possibilities. The *traditional car-oriented* (group 1) illustrate this point best: they do not just emerge out of their residential context, their travel attitudes and mode choices also arise as a result of their preference for living in the countryside. Given that they are constrained by their car-dependent environments, behavioural interventions can only be successful if they respond to the orientation of this group very closely.

The attitudinal profiles and behavioural characteristics in the two cities reveal significant potential for continued and future uptake of sustainable forms of urban travel. But this potential can only be unlocked through interventions that are tailored to group-specific preferences, needs and constraints. The role of context is crucial here, as it determines the feasibility of interventions in general and commands a sensitive interplay of 'hard' and 'soft' policy instruments. Future research should further evaluate the extent to which context shapes attitudes and the extent to which these attitudes affect choices about future context. Viewing and evaluating policy interventions, not just in terms of their physical and financial appropriateness but also in relation to the prevailing drivers of behaviour, is crucial for building realistic scenarios and devising strategies that effectively encourage sustainable forms of urban mobility.

Convenience

Changing behaviour towards more sustainable transport requires understanding attitudes towards alternatives.

Photography: Agencja Fotograficzna Caro / Alamy

Appendix – Statistical methods used for sample segmentation

After a series of PCAs and reliability tests, 12 components were selected in both cities for further analysis based on their reliability (see Fig. A.1). In addition, residential preferences were included which were captured in a multi-nomial variable of five categories, each representing an 'ideal' residential environment that respondents had to choose from (including a category 'other'). The variable was recoded into binary variables representing each of the categories.

The statistical technique used to create the typology was cluster analysis. We combined a hierarchical clustering algorithm (HCA) with Ward linkage and a k means clustering. HCA helps decide a suitable number of clusters, which can then inform the cluster initialisation of the iterative k means algorithm. The k means clustering takes the cluster centres of the HCA cluster solution as input and re-clusters the sample according to the square Euclidean distance from the centres. Since HCA does not correct cluster assignments, k means can generate more homogeneous groups and hence improved solutions, as measured by the ratio between within cluster and between cluster variance.

The identified segments were then investigated with respect to their socio-demographic composition, observed travel behaviour, residential location and selected indicators about future intentions and behavioural change. Significance of differences was tested through one-way ANOVAs and Tukey post-hoc tests, where we compared means; and chi-square tests, where we compared relative frequencies of categorical variables across clusters. The statistical software package used was R. For data management and statistical analysis, the base package of R was used. PCAs have been run using the *princomp* function of R's stats package. *The alpha function* (package: *psych*, Revelle 2013) was used to calculate Cronbach's alpha. The clustering was performed using R's *hclust function* (package: *stats*), whose resulting cluster centres were fed into the *kmeans* algorithm. The clusters were investigated by means of weighted statistics, chi-squared-based tests, oneway ANOVA and Tukey post-hoc tests (packages: *Hmisc*, Harrell et al. 2014 and *car*, Fox and Weisberg 2011). Spatial characteristics of respondents' residences were estimated using packages *rgeos* and *maptools* (Bivand and Rundel 2013; Bivand and Lewin-Koh 2013).

Fig. A.1. Scales derived from Principal Components Analysis

	Scales and questionnaire items	No. of items	Cronbach alpha		comments
			Berlin	London	
1	auto: affinity towards driving	5	.800	.816	–
2	cycling: affinity towards cycling	3	.827	.855	–
3	transit: affinity towards public transport travel	7	.854	.862	–
4	trains: affinity towards train travel over long distances (intercity travel)	6	.865	.881	–
5	mobility services: affinity towards using mobility services (car rental, rental bicycles, transport maps, online tickets)	5	.890	.923	–
6	innovation: competence and interest in travel, e.g. “I like trying out new mobility services”	7	.868	.903	–
7	technology: propensity to use digital technology (e.g. smartphones)	2	.781	.790	–
8	environment: importance of the protection of the environment	4	.782	.856	–
9	auto fun: degree of enjoying driving	2	.487	.232	excluded
10	central: preference for living in central urban areas	1	–	–	binary
11	residential: preference for living in purely residential urban areas	1	–	–	binary
12	outskirts: preference for living in the city outskirts	1	–	–	binary
13	countryside: preference for living in the countryside, outside the city	1	–	–	binary
14	apps: propensity to use smartphone apps	3	.747	.812	excluded
15	data protection: importance of data privacy	3	.672	.751	excluded
16	personal space: importance of personal space during travel	2	.799	.751	excluded
17	social norm: importance of what friends or relatives think about one’s behaviour	3	.769	.815	excluded

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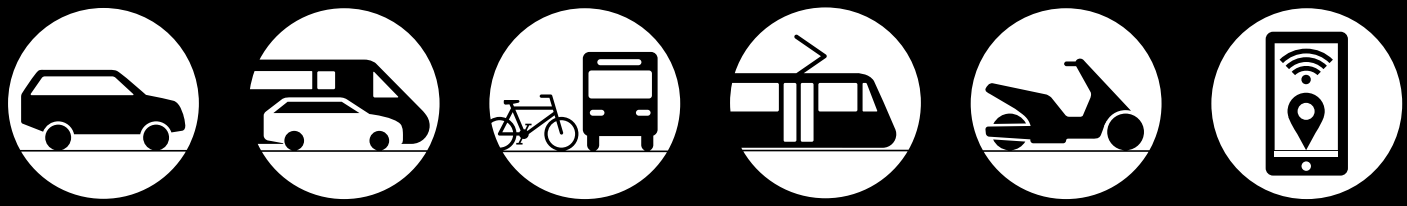

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InnoZ's research focuses on future sustainable mobility concepts in the context of societal change. We are particularly interested in Mobility2Grid solutions and how they are implemented, eventually adopted and whether they are economically viable. This research agenda, undertaken in an interdisciplinary fashion, allows us to coordinate complex and large-scale projects in the realm of transport, ICT systems and energy. Notably, we involve potential user groups and stakeholders during all phases: from early development, to testing and eventually market launch.

InnoZ is mainly located on EUREF-Campus, which seeks to implement the vision of an "Intelligent City" of the future today. The campus, with its environmentally and economically sustainable solutions, is a place where ideas and enterprises of the future can evolve and is thus a centre for innovation – unique in the European research sphere. InnoZ contributes to German and European innovation initiatives with its research projects and its on-site "ElectroMobility Platform", a space which functions as a living lab, exhibition centre and forum.

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