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Ranking of European Cities in
Sustainable Transport

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Ranking of European Cities in Sustainable Transport

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Wuppertal Institute

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1 Executive Summary

Europe is the third most urbanised region in the world, with its urban population expected to increase to over 80% in 2050 (UN 2015). Cities are home to over 70% of the current EU population and account for some 85% of the Union's GDP. Most journeys begin and end in cities. Therefore, any effort to cut transport-related CO₂ emissions must take urban mobility into account. An efficient transport system is an important factor that makes cities competitive. It provides access to jobs, education and healthcare.

In many urban areas, an increasing demand for transport has resulted in more vehicles on the roads, thus creating congestion and an unsustainable situation. Besides the economic loss of time, motor vehicle congestion worsens the air quality and liveability of these cities. Worsening air quality is one of the major threats that endangers public health and many European cities struggle to provide reasonable air quality. Reducing the share of internal combustion engines should be a priority to improve air quality and reduce emissions.

Car-based urban transport systems, which rely on fossil fuels, also deplete precious environmental resources and accelerate climate change. Furthermore, the increase of motor vehicles on the roads reduces safety for other users, such as cyclists and pedestrians. Road accidents and fatalities take their toll on the youth – the future of Europe.

This report on urban mobility performance measurement is aimed at enabling European city stakeholders and the public to understand their current urban mobility situation through a point-based results framework. The study provides cities with a yardstick to measure their performance and benchmark their progress against some of their counterparts. It measures the urban mobility in 13 European cities: Berlin, London, Vienna, Brussels, Moscow, Rome, Zurich, Paris, Amsterdam, Copenhagen, Oslo, Budapest and Madrid. Some of these have made announcements to remove cars from their cities, while others are subject to legal action for infringing EU limits for air quality.

To measure sustainable transport and mobility in these cities, the report analysed them through 21 indicators, categorised to represent the performance of public transport and active mobility (i.e. walking and cycling), the state of road safety, air quality, and the progress in mobility management. The data, on which this analysis is based, was obtained from official sources available either in the public domain or through direct communication with city officials working in relevant departments. An absolute ranking scale is developed for each of the 21 indicators, with an overall total maximum score of 100 points. The ranks can be seen from the table below.

Table 1-1: Overall and categorical ranks of the cities analysed. Source: Wuppertal Institute analysis

City	Overall Rank	Public transport	Road safety	Air quality	Mobility management	Active Mobility
Copenhagen	1	8	1	2	1	2
Amsterdam	2	13	1	6	3	1
Oslo	3	10	1	1	4	5
Zurich	4	1	5	2	7	8
Vienna	5	2	6	2	9	7
Madrid	6	6	4	7	7	5
Paris	7	2	9	12	9	4
Brussels	8	11	10	2	11	9
Budapest	9	2	8	8	11	11
Berlin	10	12	11	8	5	3
London	10	7	12	8	2	9
Moscow	12	2	7	13	5	13
Rome	13	8	13	8	13	12

From our overall scoring, we find that Copenhagen ranked 1st, Amsterdam 2nd and Oslo 3rd. On the lower end, London ranked 10th, Moscow 12th and Rome ranked 13th. It is important to note that a city ranking low in this sample of 13 European cities does not mean that its urban transport performs poor in every category. For instance, most of the 13 cities have well performing public transport systems. The main findings and recommendations for each of the categories we analysed are as follows:

Public Transport:

Cities were ranked based on their existing public transport modal share, affordability of the system, annual use and the access to public transport. Zurich has the most affordable and a highly used public transport system. The success of Zurich is due to its expansive system that creates a network and is integrated with other public transport options (bus and tram) in terms of fare, timetables and infrastructure.

In the high ranking cities it can be seen that when public transport is provided as a network and is integrated between rail and road-based systems, there are more people using the system. A public transport network can also cover more city area than a few lines of metro or tram, therefore a network is crucial in large cities.

Furthermore, a single ticket that allows users to switch between tram and bus to complete one journey increases the ease of travel compared to buying a ticket for every transfer.

Road Safety:

In road safety, we ranked the cities based on fatalities of pedestrians and cyclists and on crashes per 10,000 cycling trips and crashes per 10,000 pedestrian trips. The first place was shared between Copenhagen, Amsterdam and Oslo. Both Copenhagen and

Amsterdam have heavily invested in improving facilities for walking and cycling. Segregating bicycles from motor vehicles not only improved the share of cycling but also increased safety for cyclists.

In Oslo, the process-based approach in reaching a target of zero fatalities —Vision Zero Policy— has integrated urban design and technological solutions in road safety. The analysis shows that through ambitious road safety targets and strategies that prioritise safety of vulnerable road users, cities are made safer.

Air Quality

Oslo is the only city in the analysis that has concentrations below both the EU limit and the WHO guideline. Oslo's score in air quality can be attributed to the stringent Norwegian air quality regulation, which has limits stricter than that of the EU. Oslo is also closing its city centre for cars. Several parking places were removed and bicycle lanes were introduced. The analysis points to the fact that increasing public transport use improves air quality.

Mobility Management

Copenhagen ranked 1st with low emissions zones, low congestion, shared mobility, smartphone apps for public transport and, more importantly, a high cost of parking. London ranked 2nd for similar reasons as Copenhagen and, in addition, the presence of a congestion charge. With no fiscal measures and lenient policies encouraging motorised travel, Rome ranked 13th.

The analysis and experience show that charging motorists the true cost of travel deters the use of motorised trips. Often, car users are unaware of the true cost of their travel. The subsidies come in the form of free or cheap parking, no charge for the air pollution that the vehicle causes, the massive urban space occupied by roads, and the social costs imposed on other non-motorists.

Cities have shown that charging motorists the real cost of their trips encourages car users to shift to cycling or public transport and reduce unnecessary trips.

Active Mobility

Amsterdam and Copenhagen ranked 1st and 2nd place and Berlin ranks 3rd in active mobility. At the same time, Copenhagen and Amsterdam also rank high in road safety and Copenhagen ranks 2nd in air quality. All three of these cities show that providing infrastructure for cycling, increases the share of cycling. Berlin, whose inhabitants have a strong penchant for cycling, show that painting cycle lanes on the streets, rather than having physically segregated bicycle tracks as in Copenhagen and Amsterdam, will lead to higher crashes among cyclists. Berlin has over 163 crashes for every 10,000 bicycle trips, while Copenhagen and Amsterdam have 7 and 12 crashes, respectively, for every 10,000 bicycle trips.

Integration, integration, integration

In the analysis we found that the top-ranking cities have integrated planning, integrated infrastructure and integrated decision-making. Top ranking cities kept in mind the needs of pedestrians, cyclists and other road users while planning. The street designs developed by Copenhagen, for example, clearly allocate space for walking, cycling, public transport and motor vehicles. City centres are designed around pedestrians and cyclists' needs. Cars do not dominate the design, but are just another user of the space.

While providing infrastructure, the needs of pedestrians, cyclists, as well as users with special needs, are kept in mind. Public transport is integrated between modes i.e. with one ticket a user can complete the journey on different modes of transport.

To provide integrated services, different departments in the city need to come together and this was found in the top-ranking cities. Integrated decision-making removes a silo approach to sustainable mobility e.g. trying to promote cycling through bicycle sharing without the provision of bicycle infrastructure.

Leaders of change and leaders for change

Many cities are in a constant search to address issues, such as poor air quality, dwindling shares of public transport, hostile roads and worsening congestion. The initial but crucial step to address these issues is a strong and unwavering political leadership. In all of the cities that ranked high we found strong leadership spearheaded decision-making.

Strong political will in promoting sustainable mobility is the touchstone for a cleaner, safer and more liveable city. City leadership that embraces sustainable mobility accepts that transport infrastructure needs to move people and not cars. City leadership that prioritises car use and allocates public money for improving infrastructure that supports car use, will keep searching, in vain, for solutions to create liveable, cleaner and safer cities. Car-dependant policies will drive the city's future far away from being a city of the people and for the people.

2 Sustainable Urban Mobility in Europe

Despite being known for their progressive approaches and standards in sustainability, European cities have been undergoing an increasing trend towards motorisation. This can be seen, for example, by the number of new registrations of passenger cars in the European Union shown on Figure 2-1, as indicated by the European Automobile Manufacturers' Association (ACEA). Although the share of electric vehicles has only moderately increased between 2016 and 2017, the car market has equally increased over this time period. In 2017, 15.1 million new passenger cars (all vehicles) were registered in the European Union.

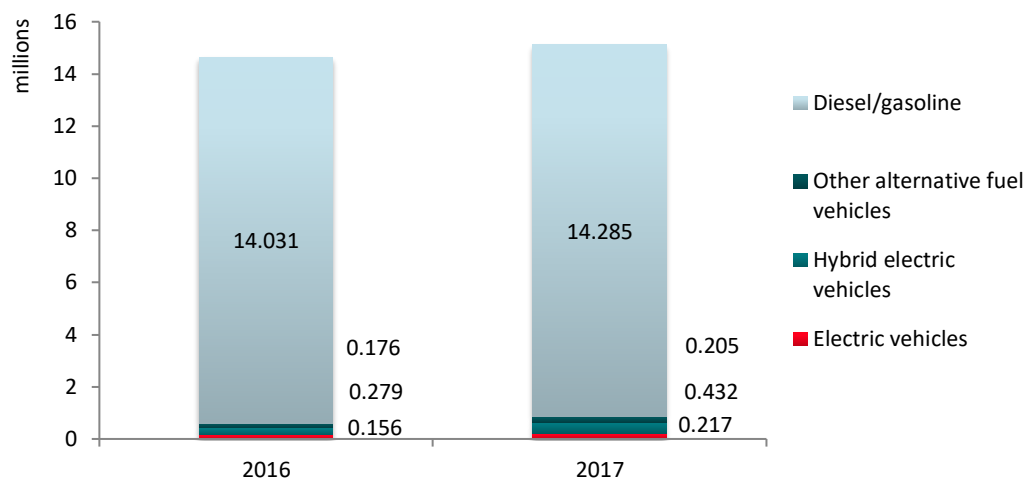


Figure 2-1 Registrations of new passenger cars in the EU in 2016 and 2017. Source: Website ACEA

European cities, some burdened by deteriorating air quality and some benefiting from a green minded leadership, have embarked upon practices to create people friendly urban mobility i.e. by promoting more walking, cycling and public transport. The EU has enabled and encouraged the planning, developing and implementation of sustainable urban mobility through its Sustainable Urban Mobility Plan (SUMP) Initiative. Strategies in the SUMP include policies and projects aimed at pushing motor vehicle drivers away from using personal vehicles in city centres, and making public transport and active mobility more attractive.

City leaders have publicly acknowledged that the increasing share of fossil fuelled vehicles contributes further to the deteriorating air quality and quality of life. Excessive motorisation has also lead to a loss of urban space and economic losses due to congestion.

This study aims to provide cities with a yardstick with which to measure their performance and benchmark their progress against some of their counterparts in the region. This study provides a verified basis for cities to further promote sustainable mobility and enable them to identify potential areas that need further development. It aims to enable local authorities and other stakeholders to understand their current urban mobility situation through a point-based results framework.

An overview of the cities, which are ranked in this study are provided in the table below:

Table 2-1 European City Ranking Overview. Source: Wuppertal Institute Compilation

City	Country	Population	City Area (sq. km)	Urban Density (p/sq. km)
Amsterdam	Netherlands	851,573	219.32	3,882.79
Berlin	Germany	3,670,622	891.70	4,116.43
Brussels	Belgium	1,175,173	161.38	7,282.02
Budapest	Hungary	1,759,407	525.20	3,349.98
Copenhagen	Denmark	763,908	86.39	8,842.55
London	United Kingdom	8,787,892	1,572.00	5,590.26
Madrid	Spain	3,165,541	604.30	5,238.36
Moscow	Russia	12,228,685	2,511.00	4,870.05
Oslo	Norway	669,060	480.76	1,391.67
Paris	France	2,229,621	105.40	21,153.90
Rome	Italy	2,877,215	1,285.00	2,239.08
Vienna	Austria	1,867,960	414.65	4,504.91
Zurich	Switzerland	402,762	87.88	4,583.09

The report's underlying research had the following objectives:

- Develop, review and revise sound indicators for measuring urban mobility performance in European cities;
- Implement the indicators to measure the urban mobility in 13 pre-selected European cities;
- Compare the project cities and rank them based on their score;
- Highlight good practices and policies that encourage sustainable urban mobility.

3 Methodology

The study focused on measuring and ranking the urban mobility performance of 13 major European cities. This study is an initial step by Greenpeace in scaling-up efforts based on previous experience at a national level. Previously, Greenpeace conducted performance measurements on urban mobility in Germany and Austria and with this study the experience is transferred to a regional level. The city selection was partly influenced by the city's existing reputation in urban mobility and partly by the EU air quality infringement procedures. We wanted to see if there exists a correlation between improving sustainable mobility, abating air quality, and increasing road safety in the biggest cities.

In measuring the performance of urban mobility, 21 indicators were selected and then divided further into 5 categories. Each category has a maximum score of 20 points such that the total score is equal to 100 points.

The categories are mentioned below, the number of indicators in each category are mentioned in parenthesis:

- 1) Public Transportation (4 indicators)
- 2) Road Safety (4 indicators)
- 3) Air Quality (3 indicators)
- 4) Mobility Management (7 indicators)
- 5) Active Mobility (3 indicators)

The indicators in each category have an individual score. Each indicator is ranked on an absolute scale developed for each indicator. Table 3-1 gives an overview of the indicators under each category and their respective maximum scores.

The sum of the scores of all the indicators, in a category, gave the categorical score, and the sum of all categorical scores gave the overall score. The overall score was then used for the overall ranking and the categorical scores were used for categorical ranking.

It is important to note that this study compares the cities' sustainable mobility performance against each other. That is, a city ranking low in this sample **does not necessarily mean that its urban transport performs badly at a global scale and that decision makers are not ambitious enough**. For instance, all of the cities have well performing public transport systems.

However, the real objective should be to develop sustainable transport and mobility, which demands the replacement of the fossil-fuelled internal combustion engine. Cities ranking high deliver better on their sustainable mobility objectives and are making evident strides to move away from individual motorised mobility.

Table 3-1 City Ranking Indicators. Source: Wuppertal Institute Methodology

Ranking category	Indicators used	Unit	Max. score per indicator
Public transport	% of public transport trips	Public transport modal share in %	5
	Cost of a single journey on Public transport	Price of the minimum single journey ticket adjusted against cost of daily food (%)	5
	Annual trips per person	Annual trips / population	5
	Station density	Stations / sq. km	5
Road safety	Fatalities for bicycles	Fatalities/yr.	5
	Fatalities for pedestrians	Fatalities/yr.	5
	Crashes for bicycles	Crashes for every 10,000 bicycle trips	5
	Crashes for pedestrians	Crashes for every 10,000 walking trips	5
Air quality (annual average)	NO ₂ / Nitrogen dioxide	µg/m ³ /yr.	10
	PM ₁₀ / Particulate matter 10 µm	µg/m ³ /yr.	5
	PM _{2.5} / Particulate matter 2.5	µg/m ³ /yr.	5
Mobility management	Congestion charge	Yes/no	1
	Parking prices	Price of 1 hour of parking adjusted against cost of daily food (%)	5
	Low emission zones	Yes/No	1
	Public transport apps	Ticketing / Scheduling / Both	2
	Congestion index	% of travel time lost due to congestion	6
	Shared cars / sq. km	Cars / sq. km of service area	2.5
	Shared bicycles / sq. km	Bicycles / sq. km of service area	2.5
Active Mobility	% of walking in the city	Walking trips modal share in %	6
	% of cycling in the city	Cycling trips modal share in %	12
	Urban green cover	% of green spaces in the city	2

Data availability

While collecting data, it was ensured that the data used was for 2017. In the cases where the data for 2017 was not available the latest available data was used instead.

An important caveat with respect to the modal split must be pointed out: cities use different methods to identify their modal split and the respective method can influence the final result. Most importantly, the modal share can either be obtained from a household survey, which delivers the inhabitants' mode share; or it can be obtained from traffic counts, a method which considers all travellers and thus also includes mobile persons, other than the inhabitants, such as tourists.

In this study, no adjustment methods were applied for any of the given modal split data (unless explicitly stated), irrespective of the underlying data collection method. This due to the fact that any adjustment would need considering additional disaggregated data for analysis, which was not available. However, the modal split data was deemed comparable, as it is a common approach to rely on public authorities' studies in any comparison of urban mode shares. In all cases, the modal split includes any trip within the city's boundaries and any regional (short distance) trip with the origin or destination within the respective city.

For two indicators¹, affordability was measured. In these cases, the price is the calculation unit, and food was considered as the purchasing power. That is, additional information was obtained to normalise the scores. Affordability is measured by comparing the actual cost against the cost of the daily food intake (of 2,400 calories) in each city²; 2,400 calories is the daily recommended caloric intake for an average adult³.

¹ Indicators for measuring the affordability of public transport and affordability of parking

² Data obtained from surveys conducted by www.numbeo.com

³ <https://health.gov/dietaryguidelines/2015/guidelines/appendix-2/>

4 Overall ranking

The overall rank of the indicators reveals that the top spot was taken by Copenhagen, followed by Amsterdam, Oslo and Zürich. More automobile dependent cities scored poorly due to the leniencies in their policies which encourage the use of personal automobiles.

The cities in the ranking were, at one point, in the media for the announcements from their leaders to improve urban mobility. Some cities are in the process of implementing the announced plans and some are yet to turn their words into actions.

The overall performance of the cities can be seen in Table 4-1 and Table 4-2 illustrates the categorical ranking. The categories and the ranking are elaborated in the following chapters.

Table 4-1 European city ranking overview. Source: Wuppertal Institute analysis

Rank	City	Overall score	Public transport	Road safety	Air quality	Mobility management	Active mobility
1	Copenhagen	57.00	6.75	16.00	14.00	10.50	9.75
2	Amsterdam	55.00	4.50	16.00	13.50	8.75	12.25
3	Oslo	50.00	6.00	16.00	14.50	8.00	5.50
4	Zurich	47.75	10.50	11.50	14.00	7.00	4.75
5	Vienna	44.75	8.50	10.50	14.00	6.50	5.25
6	Madrid	43.50	7.50	12.00	11.50	7.00	5.50
7	Paris	38.75	8.50	8.50	9.50	6.50	5.75
8	Brussels	38.00	5.75	8.00	14.00	6.25	4.00
9	Budapest	37.75	8.50	9.50	10.00	6.25	3.50
10	Berlin	34.50	5.50	5.00	10.00	7.50	6.50
10	London	34.50	7.00	4.50	10.00	9.00	4.00
12	Moscow	30.75	8.50	10.00	3.50	7.50	1.25
13	Rome	27.00	6.75	2.00	10.00	5.00	3.25

Table 4-2 Categorical ranking of the European cities. Source: Wuppertal Institute analysis

City	Overall Rank	Public transport	Road safety	Air quality	Mobility management	Active Mobility
Copenhagen	1	8	1	2	1	2
Amsterdam	2	13	1	6	3	1
Oslo	3	10	1	1	4	5
Zurich	4	1	5	2	7	8
Vienna	5	2	6	2	9	7
Madrid	6	6	4	7	7	5
Paris	7	2	9	12	9	4
Brussels	8	11	10	2	11	9
Budapest	9	2	8	8	11	11
Berlin	10	12	11	8	5	3
London	10	7	12	8	2	9
Moscow	12	2	7	13	5	13
Rome	13	8	13	8	13	12

5 Modal Share

Modal share (or modal split) depicts the percentage (%) share of trips by different transport modes in a city. The most often reported categories are public transport (including bus, metro rail, trams, waterways), active mobility (walking and cycling), and personal automobiles (cars and motorised two wheelers). Some cities also document taxis and shared cars as a separate category.

Cities with a high share of sustainable modes i.e. public transport, walking and cycling, have a higher possibility to increase or maintain the share of these modes, if the right policies and measures are put in place.

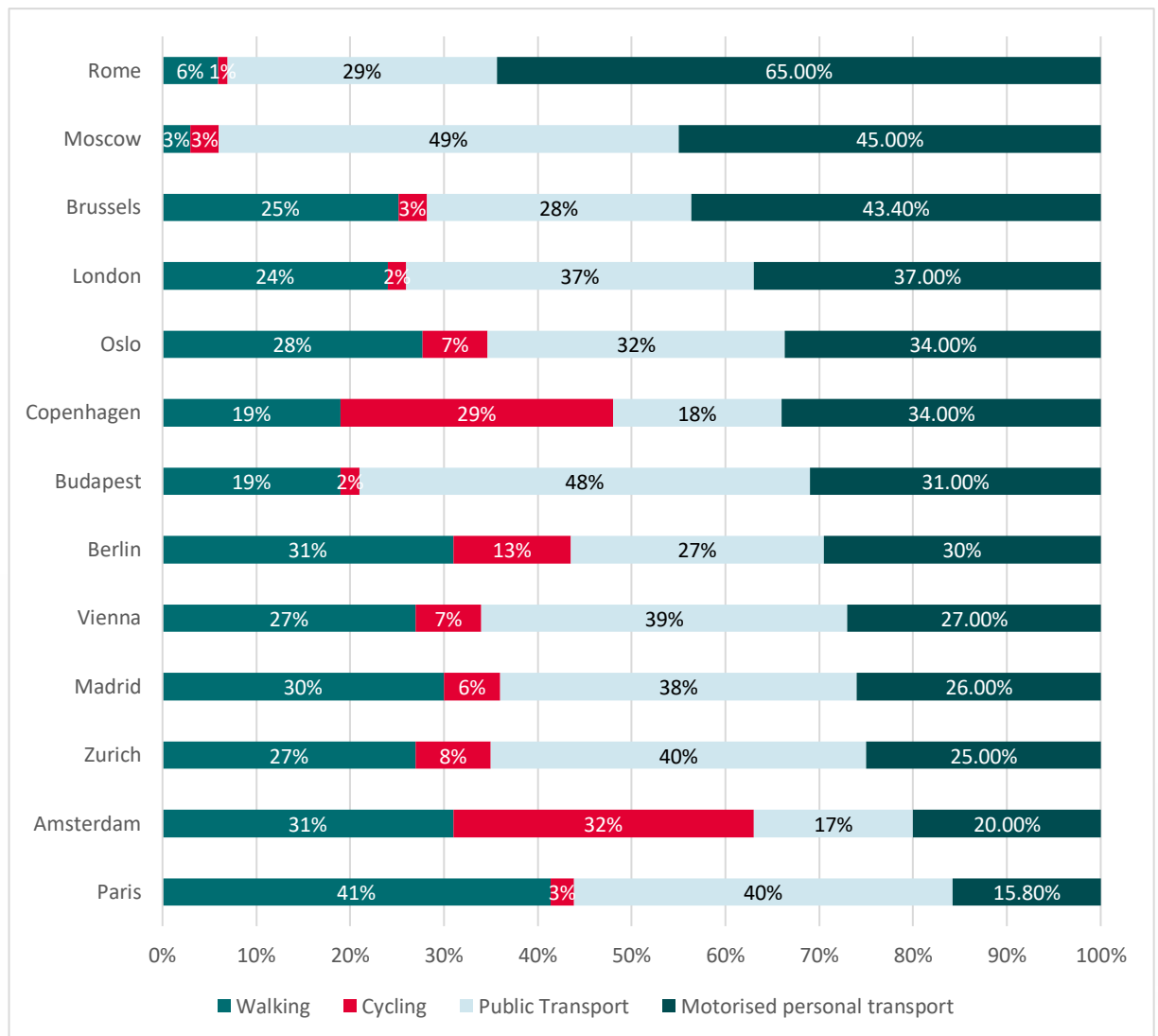


Figure 5-1 Transport modal shares in the 13 European cities. Source: see list of references

In this ranking, wherever taxi data is available it is included in the public transport share, and shared cars are aggregated under personal automobiles. This is due to the fact that shared cars still contribute to congestion, air pollution and are often single person trips. Taxis on the other hand replace additional motorised trips and the

occupancy rates are higher for taxi trips. Figure 5-1 shows the shares of urban transport modes in the analysed cities.

Paris has the least share of personal automobiles (15.80%) closely followed by Amsterdam (20%) and Zurich (25%). Amsterdam leads in cycling with 32% of trips, and Moscow leads in the share of public transport trips at 49%. Rome on the other hand has the highest share of personal automobiles (65%).

To calculate Paris's modal share, we have taken a weighted average of Paris-Paris modal share and Suburban – Paris modal share. The reason being that the Suburban-Paris trips account for 4.3 billion trips and we presume that the Suburban – Paris trips contribute to the walking, cycling and public transport trips, which are counted under the Paris-Paris trips.



Figure 5-2 A congested street in Rome. Source: [faungg's photos](#) / [CC BY-ND 2.0](#) / Flickr

6 Public Transport

Public transportation, irrespective of whether it is rail or road based, is the backbone for any successful urban transport system. Public transport has the ability to move large numbers of people when compared to personal automobiles and thus uses the available road space more effectively, in addition to per capita transport emissions reduction.

A higher share of public transport in a city tips the scales towards sustainable mobility. When coupled with a higher share of active mobility i.e. walking and cycling and proper urban planning, the need for the usage of personal automobiles is reduced.

Literature and experience shows that attracting people to use public transport and maintaining the existing ridership of public transport depend on various factors such as the fare, coverage, frequency, comfort and reliability (Currie & Wallis 2008; Abrate et al. 2009; Loader & Stanley 2009; Dargay & Liu 2010; Mantero et al. 2013; Fearnley 2013).

The ranking of cities in the category of public transport was determined by calculating the individual scores for indicators on public transport modal share, affordability, annual trips per person and station density. Affordability here is termed as the amount of money people spend on a single public transport ticket as a share of the cost of daily food. Station density is the number of public transport stations per every sq. km of the service area of the public transport network. Each of these indicators is explained further below.

In this study, Zurich scores the 1st place in public transport followed by Budapest, Moscow, Paris⁴ and Vienna sharing the 2nd place. Brussels scored the 11th place, Berlin 12th and Amsterdam the 13th place.

Zürich has maintained its reputation as being a public transport friendly city. Vienna and Paris have invested in dense and qualitative public transport systems to increase ridership.

Moscow and Budapest have urban planning structures focussed on public transport (minly rail based systems), yet this urban planning structure is being transformed by high motorisation and poor decisions favouring personal cars.

⁴ In this study we considered the “Paris + Petite-Couronne” area as the service area for the public transport.



Figure 6-1 Tram and Bus interchange in Budapest. Source: [MunichTramSpotter](#) / [CC BY 2.0](#) / Flickr

Table 6-1 Public transport ranking. Source: Wuppertal Institute analysis

Rank	City	Public Transport modal share (%)	Affordability (Percentage of single trip ticket cost vs. daily food cost)	Annual trips per capita	Station density (Stations / sq. km)
1	Zurich	40%	11%	1193	7.86
2	Vienna	39%	28%	511	13.00
2	Paris	40%	18%	517	6.99
2	Budapest	48%	29%	1037	1.15
2	Moscow	49%	13%	293	4.67
6	Madrid	38%	22%	334	8.30
6	London	37%	89%	454	12.41
8	Copenhagen	18%	35%	512	15.23
9	Rome	29%	18%	328	5.53
10	Oslo	32%	28%	464	3.32
11	Brussels	28%	24%	314	2.55
12	Berlin	27%	39%	322	9.21
13	Amsterdam	17%	36%	275	8.95

Affordability

Affordability of public transport is an essential factor for people using the system. If users perceive that they receive value (in terms of reliability, comfort and access) for the price of a public transport ticket, the use of public transport will be high.

In this study we measured the cost of a single journey ticket on public transport. The cost was then adjusted across the cities based on the amount of money people would spend on food in a day – consisting of 2,400 calories⁵, which is the recommended daily caloric value for an average adult⁶ – in the respective city.

Hence, affordability of public transport is the percentage share of the public transport ticket in relation to the cost of daily food.

Zurich, which ranked 1st in public transport affordability, is the least expensive city for a single journey in the study. A single public transport ticket costs about 11% of the share of daily food in Zurich. In Moscow the share is 13% (2nd place) and in Paris and Rome the share is 18%, placing them both in the 3rd position for affordability. London has the most expensive system where the single journey public transport ticket is 89% of the cost of daily food and in Berlin it is 39% making it the second most expensive public transport system among the cities we scored.

The affordability indicator however does not specifically consider the performance of the system. That is, the affordability rank does not denote that a system is reliable or comfortable.

Annual trips per capita

Public transport operators report the number of people carried by the system annually. The higher the number of people using public transport, the higher are the annual number of trips by the inhabitants of the city.

London has the highest number of annual trips (3.99bn trips/yr.) on all forms of public transportation followed by Moscow (3.57bn trips/yr.) and Paris (3.41bn trips/yr.). In all of the top-ranking cities public transport is provided as a network and an integration between modes of public transport is present. For example, with a single ticket in Paris, one can complete a trip using the bus, tram and metro, if necessary.

The annual trips *per capita* show the extent of public transport use by the residents in a city. Zürich tops the ranks with close to 1,200 annual trips per person. Zürich is

⁵ Data obtained from surveys conducted by <https://www.numbeo.com/food-prices/>

⁶ <https://health.gov/dietaryguidelines/2015/guidelines/appendix-2/>

often cited as a best case for public transport in Europe due to its steady public transport ridership, which could infer contentment of public transport users. Budapest ranks 2nd with 1,037 annual trips per person and Paris 3rd with 517 annual trips per person (see Figure 6-2).

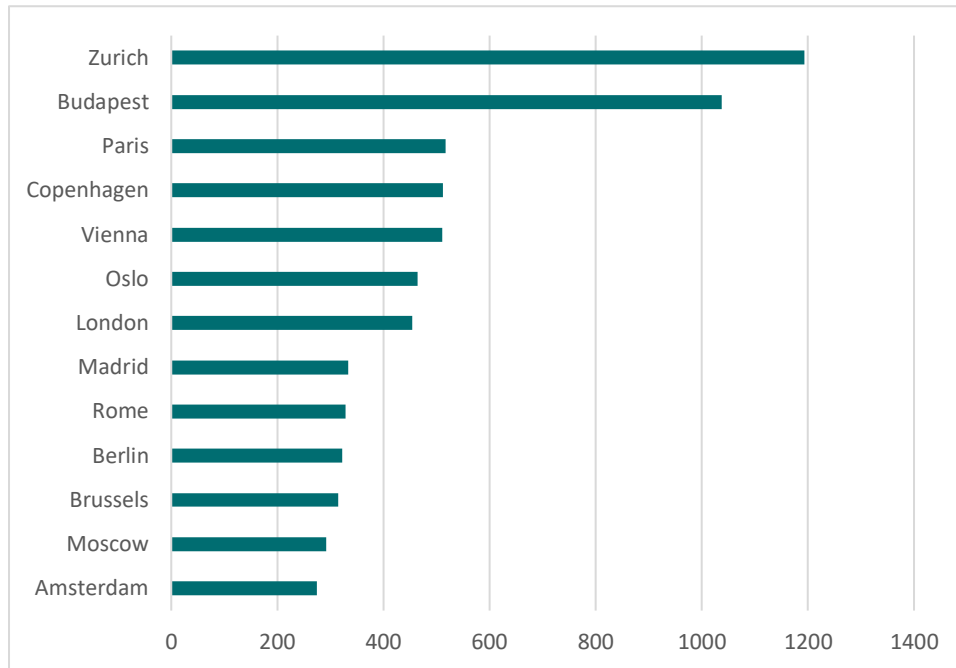


Figure 6-2 Annual trips per capita on public transport. Source: Wuppertal Institute analysis

Station density

The average number of stations in a sq. km. of the service region is denoted by station density. If the number of stations per sq. km is high, then the propensity to use public transport is also high due to the increased access to public transport. Station density is also part of the public service infrastructure mandate; the higher the station density, the easier access households without private cars have to public transport services.

Cities with a high number of annual per capita trips such as Zürich are above the average regarding station density (7.30 stations/sq.km). Moscow has 4.67 stations/sq. km and Budapest has 1.15 stations/sq. Km.

Moscow does not have a public transport system that covers the entire city, partly due to the large size of the city. Moscow is 28 times the size of Zurich or almost 5 times the size of Budapest. Implementing a large scale public transport system is resource intensive when the density of the city is low as in Moscow.

7 Road Safety

Although there has been a steep decline in fatalities and accidents in many European countries, the number of people getting injured or killed in road accidents is still high. Urban fatalities and accidents is highest among pedestrians and cyclists.

Safer roads have the potential to increase the shares of walking and cycling in cities.

People perceive walking and cycling safe if there are fewer crashes among cyclists and pedestrians.

The share of walking and cycling is low when there is an increased risk of being hit or fatally injured. The share would also be low if there is no comfortable infrastructure for walking and cycling i.e. if these users have to compete with motorised vehicles for space.

The overall results for road safety (Table 7-1) show that Oslo, Amsterdam and Copenhagen share the 1st place. Rome ranked last (13th).

In Rome, there are approximately 110 crashes for every 10,000 bicycle trips and in 2016 there were 25 bicycle fatalities – the highest in the scoring. Rome also had 47 pedestrian fatalities in 2016 and about 133 crashes for every 10,000 walking trips.

Both Berlin and London score poorly in road safety. Berlin ranks 11th and London 12th. The mayor of London has publicly announced a programme to make the city safe for walking and cycling⁷. The mayor's strategy for London is currently in its consultation phase.



Figure 7-1 Cycling in winter in Copenhagen.

Source: [Mikael Colville-Andersen](#) / [CC BY-NC 2.0](#) / Flickr

⁷ The Mayors Transport Strategy: <https://tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/the-mayors-transport-strategy?cid=mayors-transport-strategy>

Berlin is addressing its road safety issue through the reduction of the speed limits and increasing safe and comfortable infrastructure for walking and cycling⁸. In the summer of 2018, the house of representatives in Berlin will decide on a proposal by the Berlin government to promote cycling. Such a proposal if approved by the house will benefit cyclists as more resources will be allocated for cycling infrastructure and safety.

Furthermore, the results show a strong correlation between modal share and road safety. Cities with a high share of active mobility (i.e. walking and cycling trips), have fewer fatalities in these groups (see Figure 7-3). Both Amsterdam and Copenhagen have a high share of active mobility and the lowest share of bicycle and pedestrian crashes and fatalities.

Oslo, Amsterdam and Copenhagen have the least fatalities among all the cities analysed. This is also due to the road safety targets which have lead to measures such as reducing speed limits, educating drivers, increasing penalties and increasing the frequencies of motor vehicle checks.

National road safety policies such as the “Vision Zero” have had a great impact on local road safety. The “Vision Zero” policy is a process oriented approach to reach a particular target – zero road fatalities. The strategies in the policy call for a more people centred road/street design. Furthermore, as the policy is approved by political decision makers, there is accountability. Norway is one of the countries which has adopted the “Vision Zero” policy⁹.



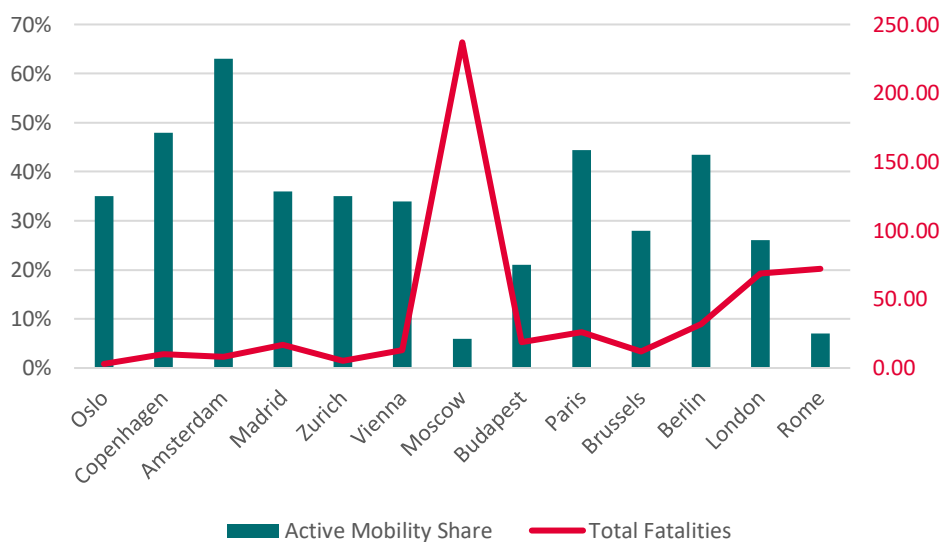
Figure 7-2 Bicycle accident at Winterfeldtplatz, Berlin. Source: [Alper Çuğun/ CC by 2.0 /Flickr](#)

⁸ Berlin road safety plan for 2020:
https://www.berlin.de/senuvk/verkehr/politik_planung/sicherheit/download/berlin_sicher_mobil2020_broschuere.pdf

⁹ https://www.vegvesen.no/_attachment/646945/binary/968554

Table 7-1 Road safety ranking. Source: Wuppertal Institute analysis

Rank	City	Share of walking trips	Annual pedestrian fatalities	Crashes for every 10,000 pedestrian trips	Share of Cycling Trips	Annual Bicycle fatalities	Crashes for every 10,000 bicycle trips
1	Amsterdam	31%	3	4	32%	5	12
1	Copenhagen	19%	5	4	29%	5	7
1	Oslo	28%	2	6	7%	1	23
4	Madrid	30%	16	18	6%	1	14
5	Zurich	27%	3	21	8%	2	143
6	Vienna	27%	11	26	7%	2	74
7	Moscow	3%	232	5	3%	5	92
8	Budapest	19%	17	12	2%	2	66
9	Paris	41%	23	19	3%	3	113
10	Brussels	25%	10	38	3%	2	211
11	Berlin	31%	17	22	13%	15	163
12	London	24%	61	26	2%	8	251
13	Rome	6%	47	133	1%	25	110

**Figure 7-3 Correlation between active mobility and fatalities 2016. Source: Wuppertal Institute analysis**

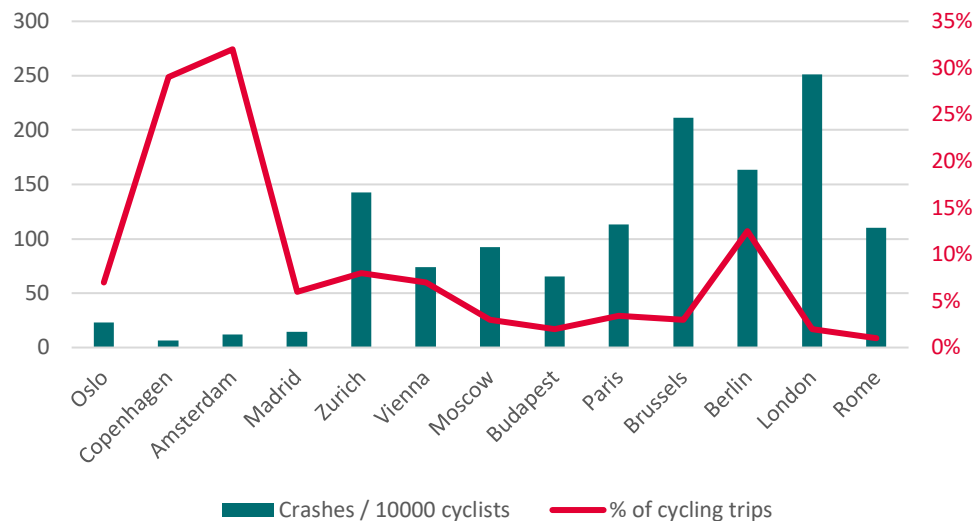


Figure 7-4 Cycling crashes for every 10,000 cyclists vs Modal Share of cycling. Source: Wuppertal Institute analysis

Figure 7-4 shows the relation between cycling modal shares and the number of crashes. As cycling numbers increase (through giving priority to bicycles on the streets), the number of fatalities and crashes involving cyclists reduce.

Cities usually struggle to improve cycling. The success from Copenhagen and Amsterdam has shown that, when there are safe, segregated and comfortable cycling conditions there will be an increase in the number of people cycling. Research calls this “safety in numbers” (Jacobsen, 2003). Several studies have shown that when motorists “see” pedestrians and cyclists on the street they will start driving in a more humane way and consider them as co-users of the road. On the contrary, fewer cyclists and pedestrians will bolster the image that the road/street is for motorised vehicles, creating a hostile space for cycling and walking.

8 Air Quality

Air pollution is the evident and first-hand experience of the effects of the increased combustion of fossil-fuels which are predominantly used in motorised vehicles. As a result, people walking and cycling inhale high doses of pollutants, while motorists also have a high exposure (Cepeda et al., 2017).

Air quality has been one of the most pressing environmental issues in Europe in the last few years. Many cities in Europe do not comply with the legal thresholds set by the European Union (EU). The EU has been approached by many think tanks and non-governmental organisations with petitions to tackle the growing air pollution problem across European countries and cities.

In the study we have selected 3 major pollutants, namely Nitrogen dioxide (NO₂), PM₁₀ and PM_{2.5}¹⁰. These 3 pollutants cause the greatest harm to human health and to the environment. The EU limit for NO₂ and PM₁₀ is 40 µg/m³/yr. and for PM_{2.5} it is 25 µg/m³/yr. The World Health Organisation (WHO) guideline for NO₂ concentrations is 40 µg/m³/yr., for PM₁₀ it is 20 µg/m³/yr. and for PM_{2.5} is 10 µg/m³/yr.¹¹

The WHO global guidelines for particulate matter – the substance that can be dangerous even at low concentrations – is much stricter than the EU standards. The particulate matter is also a reason for respiratory problems and is also carcinogenic. Particulate matter is not visible for the naked eye, it settles in the respiratory track and in the lungs of the people inhaling it.

Cities measure air quality through monitoring stations. These stations are usually located in high volume traffic areas, residential areas, and on the outer periphery of the city to measure background values for certain concentrations of pollutants. In addition to the above stations, there are also measuring stations located in rural areas and in industrial areas.

In this study we have collected annual mean data reported by the cities for the year 2017 from urban and urban background stations. This includes data from traffic, residential and urban background measuring stations within the city limits. The results of the air quality scoring are shown in Table 8-1 below.

¹⁰ PM₁₀ is particulate matter 10 micrometers or less in diameter, PM_{2.5} is particulate matter 2.5 micrometers or less in diameter. PM_{2.5} is generally described as fine particles. By way of comparison, a human hair is about 100 micrometres, so roughly 40 fine particles could be placed on its width. Source: <http://www.npi.gov.au/resource/particulate-matter-PM10-and-pm25>

¹¹ [http://www.who.int/en/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](http://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)

Table 8-1 Air Quality ranking in the European cities. Source: Wuppertal Institute Analysis

Rank	City	NO ₂ Annual Mean	PM ₁₀ Annual Mean	PM _{2.5} Annual Mean
1	Oslo	32.500	15.455	7.444
2	Vienna	31.875	19.200	13.000
2	Brussels	35.354	18.962	13.925
2	Zurich	34.000	17.600	11.000
2	Copenhagen	31.667	23.333	14.000
6	Amsterdam	33.400	21.300	13.700
7	Madrid	44.542	20.091	9.800
8	Berlin	47.147	25.000	17.000
8	London	50.800	19.400	12.400
8	Rome	47.083	26.653	15.071
8	Budapest	44.801	10.377	25.000
12	Paris	49.564	26.875	16.000
13	Moscow	66.910	46.770	28.630

From the data obtained Oslo ranked 1st, while Vienna, Zürich, Copenhagen and Brussels share the 2nd rank.

Brussels has been in the media recently for providing free public transport on high air pollution days to tackle dirty air. This led us to carefully analyse the result of Brussels in this scoring. Data collected shows that Brussels did not have any data reported in 2017 for a monitoring station 41B008 – Bruxelles (Rue Belliard). Data between 2013 – 2016 shows that this station reported values higher than the EU limit. In 2016 the station had an annual mean value of 54 µg/m³. If we use the 2016 data for this station Brussels would then score 4th instead of the current 2nd.

The air quality scoring confirms a recent report¹² that Berlin, Paris, London and Madrid¹³ have exceeded the EU limit (Figure 8-1). The highest NO₂ emitting city in the EU is London, followed by Paris, Berlin, Rome, Budapest and Madrid.

¹² <http://eeb.org/european-commission-tells-air-pollution-ministers-inaction-has-consequences/>

¹³ <https://www.telegraph.co.uk/science/2017/01/24/air-pollution-london-passes-levels-beijingand-wood-burners-making/>

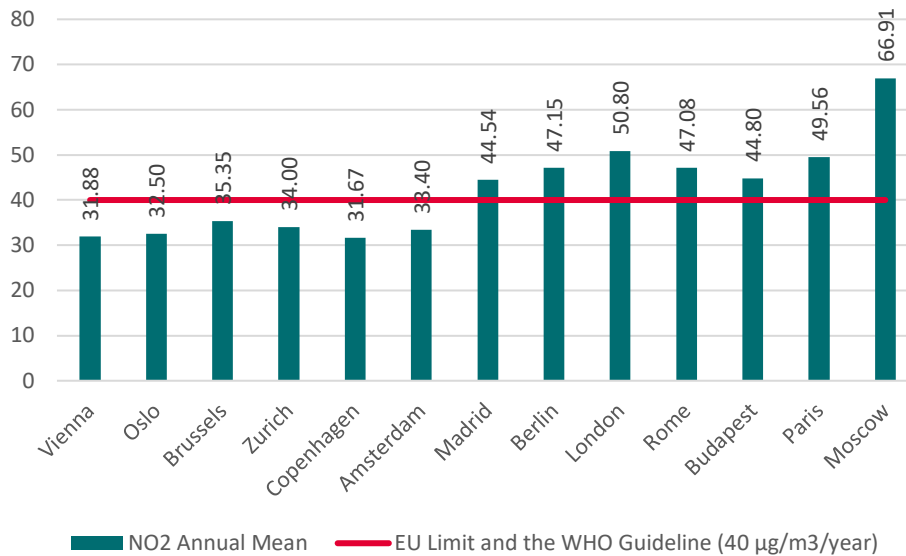


Figure 8-1 NO₂ levels in EU cities (µg/m³/year). Source: Wuppertal Institute analysis

In terms of PM₁₀ concentrations, Moscow with concentrations of 46.77 µg/m³/yr. exceeds the EU limit for PM₁₀ concentrations (Figure 8-2), while the other cities are within the EU limit.

Copenhagen, Amsterdam, Madrid, Berlin, Rome, Paris and Moscow, exceed the WHO guideline for PM₁₀ concentrations. Paris is the highest PM₁₀ emitter among the EU cities with 26.88 µg/m³/yr followed by Rome.

With more than half of the cities exceeding the WHO guideline for PM₁₀ concentrations, it is worth questioning if the EU limit for PM₁₀ is ambitious enough for cities to have clean air.

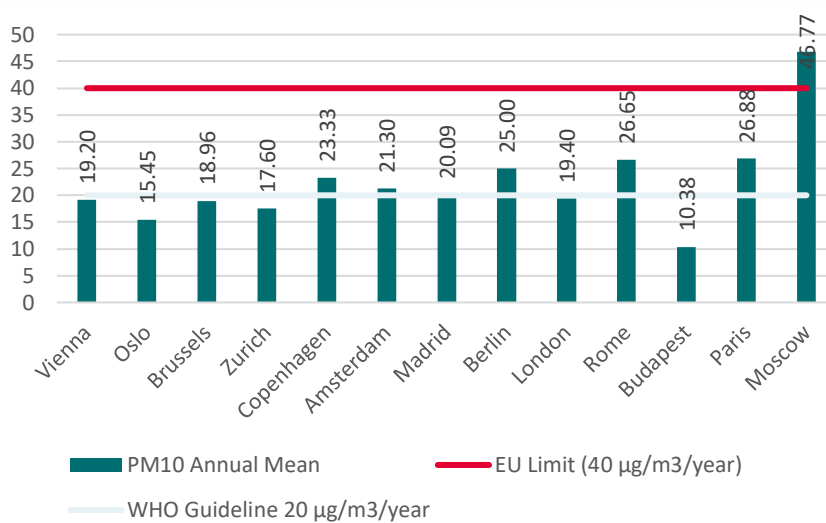


Figure 8-2 PM₁₀ levels in EU cities (µg/m³/year). Source: Wuppertal Institute analysis

With regards to the PM_{2.5} concentrations (Figure 8-3), Moscow remains to be the highest emitter. Budapest is right on the edge of the standard with 25 µg/m³ concentrations. Oslo is the least PM_{2.5} emitting city in the ranking with an annual mean of 7.44 µg/m³/yr. Excluding Oslo and Madrid, all the remaining 11 cities have exceeded the WHO guideline for PM_{2.5} concentrations. PM_{2.5} concentrations are harmful for human beings, and especially for children and the elderly. PM_{2.5} causes respiratory illnesses, harms pregnant women and increases the risk of congenital heart diseases.

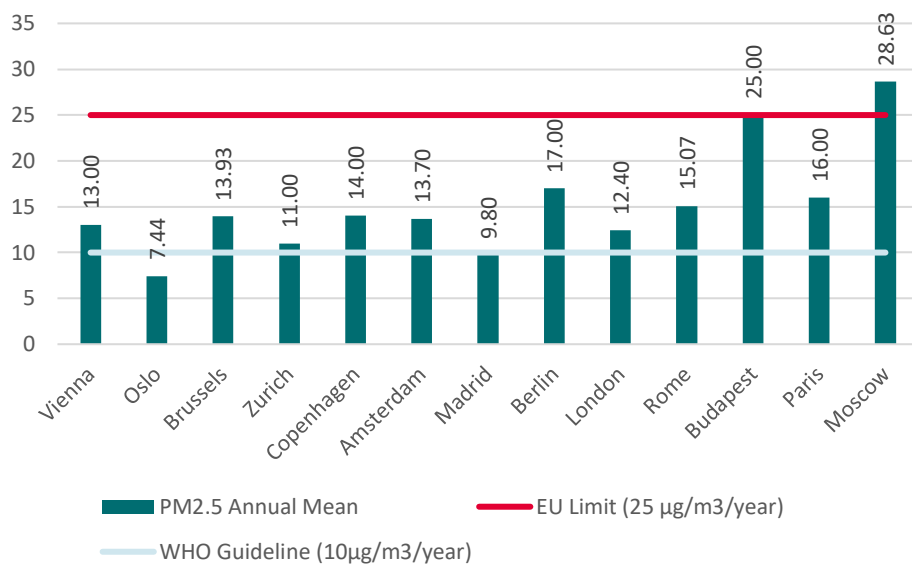


Figure 8-3 PM_{2.5} levels in EU cities (µg/m³/yr.). Source: Wuppertal Institute analysis

9 Mobility Management

Mobility Management is also called Transport Demand Management or Travel Demand Management. It is a practice in which travel behaviour is influenced and the need for travel through personal automobiles is controlled through various policy measures, financial instruments, infrastructural changes and the encouragement of alternative modes of travel.

Several European cities have implemented various mobility management tools ranging from parking pricing to more complex and politically challenging measures such as congestion charging.

In the ranking and analysis, we have included both restrictions for car use and incentives to use alternative private passenger vehicles:

- the cost for one hour of parking as a percentage share of the cost of food¹⁴ in the respective cities,
- innovative policy measures, namely whether a city has implemented a congestion charge or a low emission zone,
- incentives to facilitate the use of public transport, namely whether smartphone apps for scheduling and ticketing are available,
- the congestion index developed by TomTom, indicating the percentage increase in travel time for cars due to congestion, and
- shared cars and bicycles / sq. km of the service area¹⁵.

In the ranking Copenhagen ranked 1st for mobility management, followed by London (2nd) and Amsterdam (3rd). Brussels and Budapest are tied in the 11th place and Rome ranked 13th.

The success of Copenhagen, in this category, is mainly due to its expensive parking costs, an accessible bike sharing system and the availability of smartphone apps for both scheduling and ticketing.

London's score, in this category, was mainly due to the presence of a congestion charging scheme and the high cost of parking. London has the highest cost of parking, a resident of London would pay about 80% of the cost of their daily food to park for one hour in the centre of London. Yet, as the data shows, London has a 40% increase of travel time due to congestion. This could be due to the size of the city and only 37% share of trips by public transport.

¹⁴ Calculated here as the money spent daily for food that includes 2,400 calories – the daily recommended calorific intake for an adult.

¹⁵ For Paris, we have used the Paris + Petite Couronne region (762.4 sq. km.) as the shared mobility service extends the core city of Paris.

Amsterdam ranks 3rd as it has a high cost of parking; people pay 60% of the price of daily food intake for an hour of parking and there is a 22% increase of travel time due to congestion. Amsterdam only has a smartphone app that allows people to schedule their journey (i.e. to check the status of the bus/train) but not to purchase the ticket.

Rome, Paris and Brussels, all have a very high share of travel time increase due to congestion, the values ranging between 38 to 40%. Rome also has the most affordable parking, costing only 12% of the cost of daily food, which shows a correlation with the high rates of motorised transport use in Rome.

Table 9-1 Mobility management ranking. Source: Wuppertal Institute analysis

Rank	City	Congestion charge	Cost of 1 h parking ¹⁶	Low emission zones	Scheduling and ticketing apps	Increase in travel time (%)	Shared cars/sq. km	Shared bicycles/sq. km
1	Copenhagen	No	4.83 €	Yes	Both	23.00	9	22
2	London	Yes	5.60 €	Yes	Both	40.00	0	7
3	Amsterdam	No	5.00 €	Yes	Scheduling	22.00	5	15
4	Oslo	No	7.22 €	Yes	Both	30.00	1	4
5	Berlin	No	2.00 €	Yes	Both	29.00	3	7
5	Moscow	No	5.31 €	No	Scheduling	44.00	1	1
7	Madrid	No	2.35 €	Yes	Scheduling	25.00	3	6
7	Zurich	No	3.34 €	Yes	Both	31.00	6	13
9	Vienna	No	2.10 €	Yes	Both	31.00	2	4
9	Paris	No	4.00 €	Yes	Scheduling	38.00	5	19
11	Budapest	No	1.41 €	Yes	Scheduling	22.00	0	3
11	Brussels	No	2.00 €	Yes	Scheduling	38.00	6	33
13	Rome	No	1.00 €	Yes	Both	40.00	1	1

Cost of one hour of parking

Parking availability and the cost of parking influence the use of personal automobile. Cities with cheap and abundant parking (many examples can be found in N. America) have very high automobile ownership and dependency (Newman & Kenworthy 2015; Shoup 2017).

¹⁶ Source: Parkopedia.com

Parking management can be a powerful tool to influence mobility patterns and travel behaviour. This comprises of the control and reduction of the number of parking places and the introduction of parking fees. It is usually perceived in car dependent cities that parking should be cheap or free of charge, and an abundance of parking spaces need to be provided.

We restricted the data collection to charged on-street parking. In Berlin and Rome, for example, many streets have free on-street parking. Some cities offer free parking during evenings and weekends. Similarly, residential parking is often heavily subsidised. By paying a nominal fee, residents can obtain a parking entitlement and park on a street in a residential area. Such practices are incentives for personal automobile use, and the true cost of driving remains concealed with parking subsidies.

The analysis shows a relationship between the share of motorised modes and parking price (Figure 9-1). Rome with the most affordable parking has the highest share of motorised trips. On the contrary, Zurich with similar affordability as Rome has fewer trips on motorised modes due to a more attractive and expansive public transport system.

Moscow has expensive parking costs, yet a high share of motorised modes. The lack of public transport infrastructure covering the larger city area triggers increased motor vehicle use. The lack of a public transport network reduces access to public transport and when coupled with the lack of alternatives to cars, inhabitants are left with no choice but to drive.

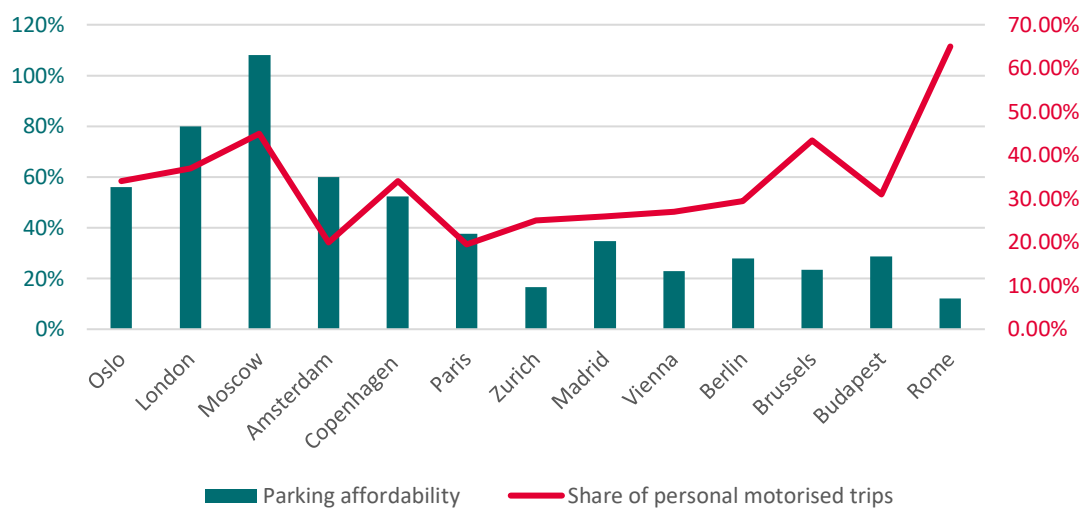


Figure 9-1 Relation between parking price vs share of motorised modes. Source: Wuppertal Institute analysis

Congestion Charging and Low Emission Zones

In the study we checked if cities have policies such as congestion charging and low emission zones. Implementing these measures helps the reduction of the numbers of certain kinds of vehicles into the city. Congestion charging, for example, has reduced traffic flowing into central London¹⁷ and has initiated a shift to higher occupancy in vehicles entering the zone. The revenue generated from the congestion charging was also used for the promotion of public transport and active mobility (i.e. walking and cycling).

Similar to congestion charging, low emission zones (LEZ) discourage polluting vehicles from entering certain parts of the city such as the city centre. A well implemented LEZ discourages vehicles with high PM_{2.5}, PM₁₀ and NO₂ concentrations and regularly revises the class of vehicles (based on their EURO standards) being restricted.

LEZs have the potential to be a good disincentive to using highly polluting vehicles in cities. In many cities the LEZs already deter vehicles of certain EURO standards from entering the city. A LEZ can also be implemented as a fiscal instrument, wherein the revenue generated can be used to promote public transport and active mobility. If restrictions are tightly set then LEZs can also encourage the use of electric vehicles.

As the main aim of a LEZ is to reduce air pollution in the implemented area and congestion charging aims to reduce the number of motorised vehicles, a new system can be devised by cities that combines the qualities of both these schemes which targets both congestion and air pollution at the same time.

Smartphone apps for public transport

Living in the digital age, many of people use smartphones. Smartphone applications (apps) make using public transport attractive. The applications can make planning a trip and buying a ticket seamless. Some smartphone apps also link various modes so that the trip planning is complete i.e. from planning a trip, purchasing a ticket and if needed using a shared mobility service for last or first mile connectivity¹⁸.

¹⁷ Mayor's Transport Strategy 2018: <https://www.london.gov.uk/sites/default/files/mayors-transport-strategy-2018.pdf>

¹⁸ First/last mile connectivity is the situation where automobile users question "how to I get to the public transport station?". Shared mobility or private hire vehicles can address this issue.

Shared Mobility

Shared mobility, especially bike sharing schemes, have been a growing trend in many cities. Shared mobility schemes give additional mobility options for inhabitants in a city. Bike sharing schemes, for example, allow people to have longer trips by linking cycling and public transport, provided the trip is within the service area of the scheme.

In the ranking we have scored the availability of shared bicycles and shared cars / sq. km of the service area. This measure shows the accessibility to shared mobility. The more they are available the higher their use could be.

Figure 9-2 below shows the number of shared bikes / sq. km versus the share of motorised trips. It has to be noted that the cities that have a lower motorisation trend didn't just fill their city with shared bicycles, but also provided infrastructure for cycling.

A possible explanation for the deviation in Brussels can be that the service area of the bike sharing system is actually smaller. As mentioned earlier if either the origin or destination of the trip is outside the service area of the bike sharing scheme a user will choose a different mode of travel to biking and using a shared mobility scheme.

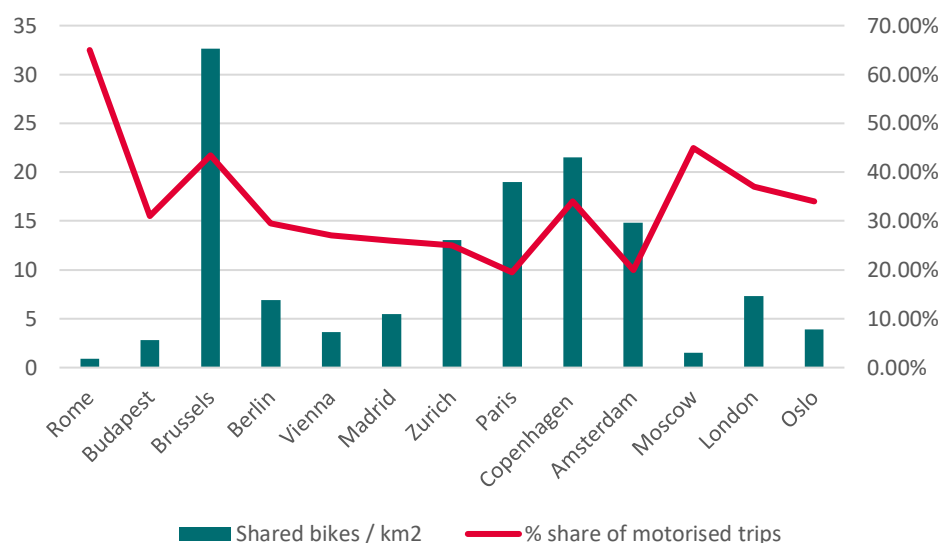


Figure 9-2 Shared bikes / sq. km vs share of motorised trips Source: Wuppertal Institute Analysis

10 Active Mobility

Walking and cycling is collectively termed as active mobility. People friendly cities tend to have a high share of active mobility. Walking and cycling can only increase in cities when there is infrastructure and policies that favour walking and cycling.

In this category, we scored the cities based on their current share of walking and cycling trips, and urban green cover¹⁹ i.e. the share of green spaces in the city.

In the scoring Amsterdam tops the rank followed by Copenhagen and Berlin. Moscow is at the bottom of the list preceded by Rome and Budapest.

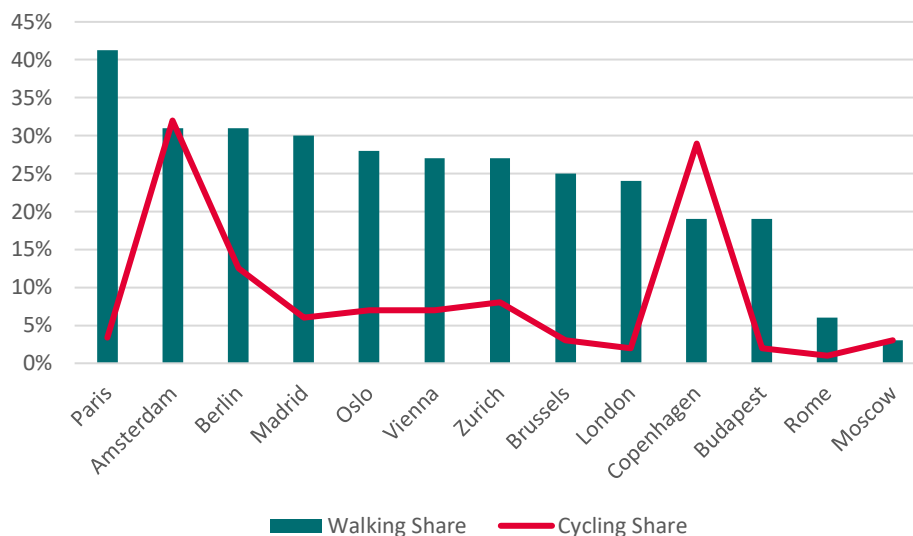


Figure 10-1 Walking and cycling shares in the European cities. Source: Wuppertal Institutes analysis

Amsterdam is popular for its high-quality bicycle facilities and infrastructure; and the score confirms this reputation. Amsterdam also has a high share of walking trips (31%) and a below average urban green cover (28.7%). The low amount of green cover could be due to the high number of waterways in Amsterdam. There are about 3,200 shared bikes in Amsterdam. We assume the shared bikes, for the greater part, are used by people who visit Amsterdam, as Amsterdam often reports that the city has more bicycles than inhabitants.

Copenhagen is also well known for its bike friendly infrastructure. The city has over 45% of the work trips done by bicycles. Copenhagen has over 400 km of bicycle lanes of which over 300 kms are segregated²⁰, and a shared bike system with close to 1,900 bicycles. The city is currently in the process of implementing a 11 km dedicated

¹⁹ European Environmental Agency Data, 2017: <http://www.eea.europa.eu/themes/sustainability-transitions/urban-environment/urban-green-infrastructure/urban-green-infrastructure-1>

²⁰ Segregating bicycle lanes increases the safety and comfort for a cyclist. Many cities tend to paint streets and count them as bicycle infrastructure. In reality, painted bicycle lanes are often encroached by motorists and increase the probability of crashes.

bicycle superhighway that is physically segregated from motorised transport and will potentially provide an artery to the city centre.

Berlin has 31% walking trips, as many as Amsterdam, a higher amount of urban green cover (39.7%) and a lower bicycle share (13%) than Amsterdam. Berlin also has an above average number of shared bicycles in the city at 6,188 bikes. The free floating, i.e. not bound to a station, type of bike sharing in Berlin allows people to pick a bike from anywhere in the city and drop it off anywhere within the service area, which is the entire city centre.

Moscow and Rome have a very high share of urban green spaces, but a very low share of cycling and walking. The reason for this contradiction is inaccessibility to green spaces, caused by the lack of integration of urban planning with the cycling and walking infrastructures. This is also evident from the high percentage of motorised modes in the cities.

With regards to bike sharing, Paris seems to have the highest number of shared bikes, yet there have been concerns from civil society groups and bicycle activist groups that the political leadership of the city is not doing enough for bicycle infrastructure.

A non-governmental observatory was established to monitor²¹ the results delivered by the leadership in Paris on bicycle infrastructure. The reports from the observatory show that there is a lack of progress on providing bicycle infrastructure.

²¹ <https://parisenselle.fr/observatoire-du-plan-velo/>

Table 10-1 Active Mobility ranking Source: Wuppertal Institute analysis

Rank	City	% of Walking trips	% of Cycling Trips	Urban green cover	Number of Shared Bicycle ²²	Kilometres of bicycle paths ²³
1	Amsterdam	31%	32%	28.70%	3,254	400
2	Copenhagen	19%	29%	22.20%	1,860	416
3	Berlin	31%	13%	39.70%	6,188	620
4	Paris	41%	3%	21.50%	14,500	778.6
5	Oslo	28%	7%	51%	1,875	60
5	Madrid	30%	6%	57.70%	3,328	195
7	Vienna	27%	7%	49.60%	1,506	1346
8	Zurich	27%	8%	26.50%	1,150	340
9	London	24%	2%	33.50%	11,500	No data available
9	Brussels	25%	3%	33%	5,264	154
11	Budapest	19%	2%	35%	1,506	200
12	Rome	6%	1%	68.30%	1,200	100
13	Moscow	3%	3%	7.03%	3,750	235

Note: Data on the length of bicycle paths in some cities, e.g. Paris, includes physically segregated, non-segregated and bicycles paths that are shared with other modes such as public transport.

²² Column for information, not used in scoring

²³ Column for information, not used in scoring

11 Conclusions

Promoting sustainable urban mobility in a city might sound easy when experts mention prioritising active mobility and public transport over personal motorised modes. However, putting the idea into practice and getting results that encourage further implementation needs a change in political mindset about motorisation, a strong political will, complete buy-in from policy-makers as well as a clear understanding of people's needs, and making sustainable mobility attractive for people. A strategy that combines all the above has the potential to initiate a behavioural change towards sustainable mobility.

At the time of conducting this study, we expected certain cities to perform better than others, based on media reports and their presence on European urban mobility project information platforms, such as ELTIS and CIVITAS.²⁴ The empirical analysis partly confirmed this perception, but it also brought about new insights and unexpected results, such as Paris's low overall rank and Amsterdam's low public transport rank. The analysis shows that promoting public transport alone will not be sufficient in establishing a truly sustainable urban mobility system as modal integration plays a key role. Parking, for example, acts as a strong instrument in controlling car use, and parking is also usually not effectively implemented, as seen from some of the cities in this study.

Furthermore, the current EU air quality standards are less ambitious and there are no stringent measures implemented²⁵ that restrict the use of polluting cars in cities.

The current study includes 13 cities across Europe. This study is also an initial attempt to measure sustainable urban mobility performance at a regional level, based on similar studies conducted at national level. Future iterations of this ranking could aim at adding additional cities, benchmarking in cities and incorporating a methodology to recognise political will.

Many of the cities that have scored poorly in the ranking e.g. London, Rome or Paris, are currently planning to prioritise sustainable mobility. City leaders have made public statements and some have started actions towards improving their urban transport and mobility systems. For instance, London has acknowledged the importance of improving air quality. The mayor has introduced a charge on polluting vehicles entering the city centre.

Similarly, Paris and Copenhagen have made a decision to remove internal combustion engine vehicles from their cities. Rome is at present in the consultation phase of developing a sustainable urban mobility plan.

²⁴ www.eltis.org; <http://civitas.eu>

²⁵ Many cities have public announced plans, we are yet to see actual implementation.

The cities in the ranking have good practices to share, and some cities are doing things right. The latter cities can be lighthouses. City leaders favouring sustainable mobility can inspire their counterparts, who do not yet recognise the potential of sustainable mobility.

In the following sections, we try to elaborate on the reasons for cities' respective ranks; and highlight potential areas for improvement in their urban mobility systems.

12 Copenhagen, Denmark

Copenhagen is the Danish capital and most populous city in Denmark. With a size of 86 sq. km, Copenhagen has a high urban density of almost 9,000 inhabitants / sq. km. Overall, Copenhagen ranked 1st in the current sustainable mobility ranking. It scored best in road safety and mobility management. In addition, it ranked 2nd in active mobility and air quality and 8th in public transport.

12.1 Modal Share

Copenhagen has invested in improving bicycling, through physically segregated bicycle lanes, bicycle parking infrastructure and integrating urban planning and bicycle planning. The result is 29% of all trips in Copenhagen are on bicycles. The city also reports more than 45% of the work trips on bicycles. Yet, Copenhagen has 34% share of trips by motorised personal vehicles.

Between 2010 – 2016, Copenhagen has reduced the amount of personal automobiles by 1% annually. The majority of the other cities have lower reductions and, in some cities, the share of personal cars has increased. Furthermore, the city has put forward

a mobility plan and targets to increase the share of cycling to over 50%. If this target is met the city will need to further reduce the personal motorised modal share.



Figure 12-1 Bicycle infrastructure in Copenhagen. Source: Santhosh Kodukula, 2016

12.2 Public Transport

Copenhagen has a low rank in public transport, it ranked 8th tied with Rome. While it does have good annual trips per capita it has a very low modal share of public transport i.e. 18%. That is, each inhabitant of Copenhagen uses the public transport 512 times a year on average. The low

use of public transport can be attributed to the high density of Copenhagen and the extremely effective bicycling infrastructure (Schwanen, 2002). Modal share for cycling is 29%, the second highest among the cities analysed.

12.3 Road Safety

Copenhagen ranks 1st in road safety, tied with Oslo and Amsterdam. The city has the least amount of crashes and fatalities in comparison to the share of pedestrians and cyclists. The number of fatalities in Copenhagen of cyclists and pedestrians is 4 and 5 per year respectively. The low rate of fatalities show that the interaction between motor vehicles and pedestrians/cyclists is minimal. Furthermore, there are about 4 crashes for every 10,000 walking trips and 7 crashes for every 10,000 bicycle trips.

12.4 Air Quality

From the data available, Copenhagen scores 2nd among the 13 cities analysed for air quality. The city's concentrations for NO₂ (31.66 µg/m³/yr.) are below the EU standard, yet high for a city that reports that more than 45% of work trips are done on bicycles. The high NO₂ concentrations are due to the high share of personal automobile trips in the city. One particular measuring station on H.C. Andersens Boulevard has been reporting high NO₂ values, although this station has had a downward trend since 2008²⁶.

The PM₁₀ and PM_{2.5} annual mean values for the city have been within the EU limits at 23.3µg/m³ and 14 µg/m³ respectively. These values have also been dropping in recent years. The concentrations exceed the WHO guidelines for PM₁₀ and PM_{2.5}, however WHO has stricter guidelines than the EU.

²⁶ <http://www.sootfreecities.eu/city/copenhagen>

12.5 Mobility Management

Copenhagen ranks 1st in the mobility management category. The cost of parking in Copenhagen is about 52% of the cost of daily food i.e. one has to pay more than half of daily food cost to park a car for one hour. The city also is reported to have a low percentage (23%) of trip time increase due to congestion, this can be due to the high share of work and school trips done by a bicycle. The city also implemented a low emission zone for heavy duty vehicles entering the city to reduce the emissions from these vehicles, which are high for a bicycle friendly city.



Figure 12-2 Bicycle sharing system in Copenhagen. Source: Santhosh Kodukula, 2016

12.6 Active Mobility

Copenhagen has a 48% combined modal share for walking (19%) and cycling (29%). It ranks 2nd in active mobility, as the city has a low amount of urban green cover (22.2%).

Nevertheless, Copenhagen has a large area of improvement for walking. With a high density and small city area, Copenhagen has a huge potential to promote walking. The city is currently constructing bicycle superhighways that shall encourage an increased use of bicycles.

12.7 Good Practice



Figure 12-3 Bicycle Superhighways in Denmark. Source: <http://supercykelstier.dk/>

Copenhagen can be a good practice case for cycling, road safety and putting in place good measures to discourage personal automobiles. In terms of cycling, Copenhagen's cycling superhighways deserve a mention. These cycling superhighways allow a fast access to destinations for regular cyclists. By physically segregating the bicycle traffic from motorised modes the safety of bicyclists is increased.

The bicycle superhighway is demarcated with a logo creating a visual distinction. The currently planned 11 km (which will be completed in 2018) will pass through the city of Copenhagen.

12.8 Areas for improvement

Copenhagen lags behind on public transport provision. It is imaginable that a city with a high share of bicycles will have less share of public transport. Yet, Copenhagen also has a high share of motorisation, this could mean that these motorised trips originate from outside the city periphery. It is also possible that the origins of the motorised trips are either not connected by public transport or the distance to the destination is too far to bicycle. Improving public transport by creating a network will potentially reduce the need for using a motor vehicle and will also have a direct impact on improving the air quality in the city.

13 Amsterdam, The Netherlands

Amsterdam with over 850,000 inhabitants ranked 2nd among the 13 European cities that were ranked. Amsterdam scored well in active mobility, road safety and mobility management. It scored average on air quality and did not perform well in public transport.

13.1 Modal Share

Amsterdam has the 2nd lowest share of personal automobiles (20%). This is due to the enormous infrastructure that the Dutch city has invested in cycling and walking over the past decades (see figure below).



Figure 13-1 A before and after picture from Amsterdam Source: <http://images.dailyhive.com/20160603092122/1.jpg>

The city has made conscious effort to move away from personal automobiles especially cars and give the streets back to the people. Between 1950 until mid-1970's bicycling was not a popular mode of transport in the Netherlands (Pucher, 2008). A massive impetus from the public and an overhaul of urban planning approaches led to decreasing the use of personal cars in Amsterdam and overall in the Netherlands.

Encouraging Cycling by Banning Scooters

In a new ruling the Dutch government has passed a rule to strictly enforce a ban on motor scooters from using a bicycle lane and enforce the use of helmets for motorists. Amsterdam is the first city to implement this new law and it is likely that many other cities will follow the trend to make cycling safer.

Source: [NL Times, 2018](#)

Box 13-1 Ban on motor-scooters in The Netherlands

13.2 Public Transport

Amsterdam has a 17% share of public transport, ranking last among the cities analysed. The result can be attributed to the high density of Amsterdam with close to 4,000 inhabitants/sq. km and a massive bicycle ridership. This means that average trip length is short and can be easily completed on foot or by bicycle. Amsterdam is

also known as a city with more bicycles than inhabitants, making almost every resident own at least one bicycle.



Figure 13-2 Trains in Amsterdam have coaches dedicated for bicycles. Source: [Martti Tulenheimo](#) / [CC BY-NC 2.0](#) / Flickr

Amsterdam provides extensive bike parking facilities around public transport stations and also allows bicycles on board of trains and trams (See Figure 13-2). The city is also in the process of extending its public transport system and once completed the system might carry more people and provide a better intermodal transport system.

Currently, Amsterdam operates a ferry transport that connects different parts of Amsterdam. The ferry system is provided at no cost.

13.3 Road Safety

Amsterdam ranks 1st in road safety, in 2016, there were 5 bicycle fatalities and 3 pedestrian fatalities. The city also has 12 bicycle crashes for every 10,000 bicycle trips and 4 pedestrian crashes for every 10,000 walking trips. Experience shows that the

probability of either a pedestrian or a bicyclist receiving a fatal impact on a collision with a bicycle is minimal. On the contrary, a collision between a motor vehicle and a cyclist or a pedestrian can be fatal.

Further, the design standards for cycling in Netherlands can be termed gold standard. Cycle tracks in Amsterdam, protect bicycles from fast moving traffic.

See Box 13-2, for more information on deciding between a cycle lane and a cycle track.

Amsterdam takes the road safety seriously and a multiyear road safety strategy²⁷ is approved and being implemented. This strategy focusses on reducing speeds of motor vehicles, increasing awareness and creating more pedestrian and bicycle friendly areas in the city.

Cycle lane or Cycle Track

Many cities spend a lot of time contemplating whether to implement a bicycle track or a bicycle lane. For those of us who need further explanation on what a cycle track and a lane is, here is our definition.

A cycle lane is not physically separated from faster moving vehicles. Usually cycle lanes are painted on one end of the road. In some cities cycle lanes share the pavement/footpath and are paved with a different material for visual distinction.

Cycle lanes are optimal if the motor vehicles do not move at a speed greater than 30 km/h.

Cycle lanes can be two directional especially in residential areas where motor vehicle speeds ought to be 20 km/h or less.

Cycle tracks are physically segregated and are (usually) wider than cycle lanes and are grade separated i.e. at a different height to a pavement/footpath. Cycle tracks provide more safety to a cyclist and are implemented on streets with fast moving motor vehicles (speeds more than 30 km/h.) Regular cyclists prefer cycle tracks as they are wider and allow them to move faster as there is less or no interaction

13.4 Air Quality

Amsterdam ranked 6th for air quality.

The NO₂ annual mean levels for Amsterdam (33.4 µg/m³/yr.) are just below the EU limit. The trend shows that the city has been reducing its NO₂ concentrations over the years.

Data shows that certain streets (Haarlemmerweg, Jan van Galenstraat and A10-West) have high NO₂ levels surpassing the EU standards. These streets would be the ones with high traffic volumes. Freight vehicles in Amsterdam travel short distances yet emit the highest NO₂ and PM₁₀ concentrations.

To address air quality the city is proposing a strategy to electrify mobility options. In a plan to become an electric city, Amsterdam proposes to increase the public charging points to 4000 by end of 2018. The city aims to have zero emissions from public transport by 2025.

Box 13-2 Cycle track vs Cycle lane

²⁷ https://www.amsterdam.nl/publish/pages/764350/meerjarenplan_verkeersveiligheid.pdf

13.5 Mobility Management

Amsterdam ranked 3rd in the category of mobility management. The city is among the least in congestion i.e. the time spent stuck in traffic was only 22% and has a high hourly cost of parking a car (5 €). The automobile restriction policies, such as the high cost of parking coupled with extensive provision for cycling in the city, deter people from using their personal cars.

Amsterdam can certainly improve in making public transport more accessible through the provision of smartphone apps for ticketing and scheduling. The current public transport app allows the user to schedule trips and know the status of buses/trains. It is expected that the smart city strategy could enable technological innovation.

Amsterdam also does not implement congestion charging. London is the only city in the 13 cities analysed to have implemented congestion charging. In 2017, the city implemented a low emissions zone restricting trucks in certain parts of the city and is planning to include taxis, coaches and mopeds to the zone restriction in 2018.

13.6 Active Mobility

Walking and cycling shares in Amsterdam are the highest among the cities analysed. Collectively the share is over 60%, enabling Amsterdam to score the 1st rank. In terms of cycling Amsterdam retains the position of best city for bicycling.

Cyclists, still, face danger from motorised two wheelers that often use the bicycle tracks for travel. There were 8000 scooters in 2007 and the number increased to 35,000 by 2016²⁸. While the municipal authorities seem powerless, the recently introduced national law can help the city in the coming months to curb the scooter mania.

28 http://copenhagenizeindex.eu/03_amsterdam.html



Figure 13-3 Physically segregated bicycle tracks in Amsterdam. Source: Benjamin Stephan / [CC BY-ND 2.0](#) / Flickr

13.7 Good practices

Amsterdam's pride lies in the extensive amount of active mobility in the city. Together, walking and cycling contribute to 60% of the trips. The high share of active mobility was possible as the city integrated urban planning and walking and cycling infrastructure. The city is also one of the most advanced cities worldwide in electric vehicles. The city currently is planning to double the publicly available charging points to 4000 by the end of 2018.

13.8 Areas for improvement



Figure 13-4 Motor scooters on bicycle lanes in Amsterdam.
Source: Franklin Heijnen / [CC BY-SA 2.0](#) / Flickr

In the recent past Amsterdam, like many European cities, has seen an increase in electric motor-scooters. The small size of these vehicles and their speed was an attraction to its users. The scooters started to encroach on the segregated bicycle paths and create a surge in bicycle crashes. Tackling the intrusion of motorised vehicles on the cycling paths is essential to make cycling safe.

In the area of mobility management, Amsterdam could increase the technological accessibility for purchasing a public transport ticket.

14 Oslo, Norway

The city of Oslo ranks 3rd in the overall ranking for sustainable urban mobility. Home to around 700,000 people, with an area of about 480 sq. km, the urban density of Oslo is about 1400 people / sq. km, making it the least dense city among the 13 cities analysed. Oslo ranked best in road safety and air quality, average on active mobility and mobility management, and ranked low in public transport.

14.1 Modal Share

Oslo is tied with Copenhagen on the share of personal automobiles at 34%, there are around 350,000 cars in the whole of Oslo. The majority of the trips in Oslo originate from outside the city. The low density of Oslo could be a reason for a higher personal automobile use. On the other hand, Oslo also has a 32% share of public transport use, which is higher than the average among the analysed cities.



Figure 14-1 Christian Krohgs gate street redesign before and after. Source: [VoX](#)

Between 2010 – 2015 the annual reduction in personal automobile use was 0.2%. The city developed a sustainable urban mobility plan and approved it in 2011. In 2015, the city leadership declared that the city centre will be completely car free by 2019 and it is in the process of redesigning various streets to prioritise walking and cycling.

Oslo aims to make the city centre car-free by 2019

In 2015 the Vice Mayor from Oslo, Lan Marie Nguyen Berg, from the Green Party announced that Oslo will implement a car-free city centre. Projects such as redesigning the streets and implementing over 60 kilometres of

14.2 Public Transport

Oslo ranks 10th in public transport among the cities analysed. Every resident in Oslo makes approximately 465 trips per year. Despite having a low-density Oslo has comparatively high annual trips. It is also possible that there is a high density around public transport stops resulting in higher annual trips i.e. people living around a public transport stop tend to use public transport more than people living away from it (Walker, 2012). Further, the cost of public transport in Oslo is 28%

Box 14-1: Announcement by Oslo to be car-free by 2019. Source: [Reuters](#)

of the cost of daily food, and public transport is more affordable in Oslo than parking. Parking costs about 56% of the share of daily food.



Figure 14-2 Tram system in Oslo. Source: [Oriol Salvador](#) / [CC BY-NC-ND 2.0](#) / Flickr

14.3 Road Safety

Oslo ranks 1st in road safety. The city has the least number of annual fatalities for pedestrians and cyclists, 2 and 1 respectively. The city has 23 bicycle crashes for every 10,000 bicycle trips. The road safety strategy is more developed in the Scandinavian cities as they have ambitious road safety targets and measures such as speed limits, regular awareness campaigns and use technology to control driver violations. The nationally adopted “Vision Zero” road safety policy brings an ethical dimension to road safety has extended the discussion beyond technical aspects of road safety (Elvebakk, 2007).

14.4 Air Quality

From the data available for 2017, Oslo ranks 1st in air quality. The annual NO₂ value for Oslo is 32.5 µg/m³, the PM₁₀ and PM_{2.5} values are 15.45 µg/m³ and 7.44 µg/m³, respectively. All values are within EU limits and have reduced compared to 2016.

Oslo is also the only city in the ranking to also have met the WHO guidelines for air quality. The WHO guidelines have a more challenging target than the EU for particulate matter.

14.5 Mobility Management

Oslo ranks 4th in mobility management. It has a high cost for parking, users pay about 56% of the cost of their daily food for an hour of parking. In terms of congestion, 30%

of trip time is increased in Oslo due to congestion. Although this does not directly denote the level of dependence on automobiles, it does show that certain streets are filled with cars during rush hour.

Oslo also has implemented a bike sharing system with approximately 4 shared bicycles every sq. km. The sharing system is seasonal i.e. it is not operational during the winter season.

14.6 Active Mobility

Oslo ranks 5th for active mobility, the city has 28% walking modal share and only 7% cycling share. The city also has over 50% of urban green space, which could make it convivial for walking. Oslo also proudly announces that about 95% of its residents have access to green space within 300m of their home.

14.7 Good practice

The road safety strategy of Oslo (and of Norway) is applaudable. The Vision Zero targets zero fatalities due to road accidents. The strategy has given road safety issues a social and ethical dimension. Unlike conventional road safety strategies, the Vision Zero works with a future target and adapting the existing practices to reach the future target.

Similarly, the air quality standards set by Norway are more stringent than EU limits. This forces cities to comply to a stricter air quality limit and enables politicians to proceed with bold plans.

14.8 Areas for improvement

Public transport and cycling are areas that need further improvement in Oslo. Increasing the accessibility of public transport and integrating public transport with cycling can boost the use of both modes. We assume that weather is a reason for many people in Oslo not wanting to bicycle. The harsh winters could discourage people to ride a bicycle.

Research has shown that increased priority to protecting cyclists and cycle infrastructure in winters leads to an increase in cycling, even during winter periods. Measures such as increasing the maintenance levels on cycle lanes i.e. by clearing snow on cycle lanes/tracks has shown to increase cycling by up to 18% in Sweden (Bergström and Magnusson, 2003).

15 Zurich, Switzerland

Zurich is Switzerland's economic capital, home to over 400,000 inhabitants and has an urban density of 4,583 inhabitants / sq. km. Zurich is often in the media due to its high rank in the quality of life surveys²⁹. In the current sustainable mobility ranking Zurich was ranked 4th among the 13 cities analysed. Zurich scored best in public transport and air quality. It scored average in road safety and below average in mobility management and active mobility.

15.1 Modal Share

Zurich has a very low share of personal automobile trips at only 25%. The majority of trips in Zurich are by public transport (40%) and on foot (27%). Cycling make up 8% of the entire share of trips. In other words, 75% of trips in Zurich are performed by sustainable transport modes. Zurich has a very people-focussed city development. The small size of the city and high density give Zurich the advantage to promote and implement sustainable mobility.

The city has a strong determination to promote sustainable mobility and increase the share of the sustainable transport modes by 2025. Among the strategies mentioned in the plan, the city aims to increase the share of cycling and public transport by creating dedicated infrastructure for cyclists and integrating public transport with walking and cycling.

In its plan, Zurich positions urban mobility as a means to increase the attractiveness of the city and making it more liveable. The city also aims to embark on a shift to electric mobility and enable the transition from the current internal combustion engines to electric vehicles. This transition will enable the city to address not only a mobility issue but also an air quality issue.



Figure 15-1 People waiting for a tram in Zurich.

Source: [Praveen Ramavath/CC BY-NC-ND 2.0/Flickr](#)

15.2 Public Transport

Zurich has scored 1st in public transport ranking of all the 13 cities analysed. The results confirm the long-standing status of Zurich to be a public transport friendly

²⁹ <https://mobilityexchange.mercer.com/Insights/quality-of-living-rankings>

city. For a city that has a high cost of living, public transport is very affordable. In comparison to the cost of daily food, public transport users spend 11% of the daily food costs for a single journey. Zurich has the highest annual trips per capita among the 13 cities we analysed. This means, on an average, a resident of Zurich uses public transport 1,193 times a year. This is the highest share among all the cities analysed.

15.3 Road Safety

Road safety for pedestrians and cyclists needs improvement. According to figures from 2016, Zurich ranked 5th in road safety. Zurich reported 3 pedestrian fatalities and 2 cyclist fatalities in 2016. The city also had 143 crashes for every 10,000 bicycle trips and 21 crashes for every 10,000 walking trips. The share of crashes among bicycle trips is not particularly encouraging, considering that only 8% of the trips are on bicycle.

When compared to Oslo, which shares similar modal share figures, Zurich is unsafe for cyclists. In Oslo, with 28% walking, there are 6 crashes for every 10,000 walking trips, and with 7% cycling in Oslo there are 23 crashes for every 10,000 cycling trips. Zurich has 6 times more cycling crashes than Oslo and almost 4 times more pedestrian crashes.

Such a high share of cycling crashes becomes a disincentive for cycling. Any efforts by the city to promote cycling might be futile if safety is not embedded in the cycling strategy.

15.4 Air Quality

Zurich ranked 2nd in air quality, tied with Brussels, Vienna and Copenhagen. Zurich follows the Swiss standard for air quality. While the maximum limits in Switzerland are different to the EU standard (for some pollutants such as NO₂, PM_{2.5}), they are more stringent.

The 2016 annual mean of the NO₂ concentrations was 34 µg/m³, which is within the EU limit of 40 µg/m³, but the value is higher than the Swiss standard which is (30 µg/m³).

Zurich's annual mean for PM₁₀ was 17 µg/m³ which is within the EU limit and the Swiss standard. The Swiss standard for PM₁₀ is at 20 µg/m³ compared to the EU standard which is 40 µg/m³. Certain streets in Zurich e.g. Manessestrasse (at 24 µg/m³), exceed the Swiss limit of 20 µg/m³. In terms of PM_{2.5}, the annual mean is 8.77 µg/m³, which is also below the EU and Swiss limits.

With regard to the WHO guidelines for air quality, Zurich is within the guidelines for NO₂ and PM_{2.5} concentrations but exceed the WHO guidelines for PM₁₀ concentrations. The WHO guidelines for PM_{2.5} is 10 µg/m³/yr.

15.5 Mobility management

Zurich ranks 7th in terms of mobility management i.e. policies that deter use of personal automobiles and encourage the use of sustainable transport modes. Despite having a high annual trips per capita and affordable public transport system, Zurich also has an affordable parking price. The cost of one-hour parking in Zurich costs 17% of the cost of daily food, while the public transport costs 11% of the cost of daily food. This means that parking is affordable in Zurich, when compared to other high-ranking cities in this category like London or Copenhagen.

Zurich is reported to have a 31% increase in travel time due to congestion. As mentioned earlier although the public transport share in Zurich is high and the share of personal automobile is low, there still seem to be a large number of motorised trips causing congestion.



Figure 15-2 Bicycle parking in Zurich. Source: [Dylan Passmore](#) / [CC BY-NC 2.0](#) / Flickr

15.6 Active Mobility

Zurich ranks 8th in the active mobility category, the collective share of walking and cycling in Zurich is 35% and majority of which are walking trips (27%). As a dense city with high public transport use, the share of walking is higher than cycling. The density also gives Zurich an advantage to further increase cycling. This is reflected in Zurich's transport strategy for 2025. The strategy aims to further increase the share of bicycle by creating new infrastructure and integrating cycling with public transport.

15.7 Good practice

Public transport and air quality gave Zurich a high score in the ranking. The extensive public transport system in Zurich forms a network which is affordable and well-used. The high use of public transport in Zurich could denote satisfaction of the public in terms of service delivery and reliability. The public transport is integrated between the modes (buses and train) and so are the fares and time-tables. A central public transport association (*Zürcher Verkehrsverbund*) manages the planning and operation of the transport system in close cooperation with city transport department.

Air quality is also a good practice in Zurich. With progressive emission standards, Switzerland's standards could be followed by the rest of EU to make air quality standard more stringent.

16 Vienna, Austria

Vienna, is the Austrian capital and the 7th largest urban agglomeration in the European Union with about 1.87 million inhabitants. Vienna also has a high urban density by European standards, at about 4,500 inhabitants/sq. km. Vienna is internationally known, in addition to being the city of music, for its ranking in the most liveable cities around the world.

In the current ranking of sustainable mobility performance Vienna scored the 5th rank. Vienna scored best in public transport, average in road safety, and low in air quality, mobility management and active mobility.

16.1 Modal Share

Vienna has a 27% share of trips by personal automobiles and over 70% of the trips are by sustainable transport modes, of which walking and public transport takes a major share. The city has an extensive public transport system and a good integration of fares, timetables and infrastructure. Due to the extensive public transport system and the constant provision of alternative modes of transport, the automobile share in Vienna has remained at 27% since 2010. The city aims to bring the share of individual motor vehicles to 20% by 2020.



Figure 16-1 Active mobility integrated with urban planning in Vienna. Source: [Pedro Szekely](#) / [CC BY-SA 2.0](#) / Flickr

16.2 Public Transport

Vienna ranks 2nd among the 13 cities analysed. The city has an annual trip per capita of 511 trips and an affordable public transport system; a single trip costs about 28% of the cost of daily food. With a modal share of 39% of the city has an extensive public transport network. Vienna has a complete fare integration i.e. one price for a journey irrespective the number of public transport modes changed in a trip. The

annual ticket in Vienna is an incentive for people to use public transport regularly. The annual ticket costs 365 Euros a year and allows the user to make unlimited trips in the core Vienna region.

16.3 Road Safety

Vienna ranks 6th in road safety. From the data available, Vienna had 11 pedestrian fatalities in 2016, and 26 crashes for every 10,000 pedestrian trips. There were 2 bicycle fatalities and 74 bicycle-crashes for every 10,000 bicycle trips. The high share of bicycle crashes justify the low bicycle share in Vienna, which is currently at 7%. Should the city want to increase the share of cycling, more effort would be required to make cycling safe and attractive.

16.4 Air Quality

Vienna ranks 2nd in air quality, tied with Zurich, Copenhagen and Brussels. The 2016 annual mean of NO₂ in the urban area is 31.87 µg/m³, which is within the EU limit. The annual mean for PM₁₀ is at 19.2 µg/m³ and PM_{2.5} is at 13 µg/m³. The city has converted much of its fleet to electric/hybrid. All the newly purchased fleet vehicles are equipped with the latest EURO standards. The city has introduced hybrid buses and the conversion of earlier EURO standard vehicles is underway to EURO 6.

Though Vienna ranks 2nd in air quality, individual stations in Vienna measured annual means of up to 49 µg/m³ for NO₂ concentrations. This shows that the urban air in parts of Vienna might not be as clean as the average value represents.

With regard to the WHO guidelines, Vienna exceeds the PM_{2.5} guidelines. For PM₁₀, the emission values are barely below the WHO guideline. This shows that the city has a high potential for public health issues if no immediate action is taken to abate the particulate matter concentrations in the city.

16.5 Mobility Management

Vienna scores 9th in the mobility management. Parking for one-hour in Vienna costs 23% of the cost daily food, which is lower than a single journey public transport ticket. Hence, parking is slightly more affordable than public transport in Vienna. Vienna has recently introduced a smartphone app that brings together the public transport planning and scheduling and also gives users the access to the other mobility providers such as car and bicycle sharing.

Vienna has a low emission zones primarily for EURO 1 and EURO 2 vehicles. While this is a positive step, it can be improved by extending the restriction to include other EURO standard vehicles, to abate the high air pollution in the city.

16.6 Active Mobility

Vienna ranks 7th in active mobility. The city does have a good share of pedestrian trips at 27%, but a low cycling share (7%). The low cycling can be improved if the safety conditions for cyclists are improved (see the Road safety section for Vienna). Segregated bicycle tracks (see Figure 16-2) can increase safety to the cyclist.

The city has almost 50% urban green cover which is encouraging for pedestrians and leisure activities. In terms of shared mobility with only 1,500 bicycles the uptake of shared bicycles is lower than the average shared bicycles among the 13 cities.

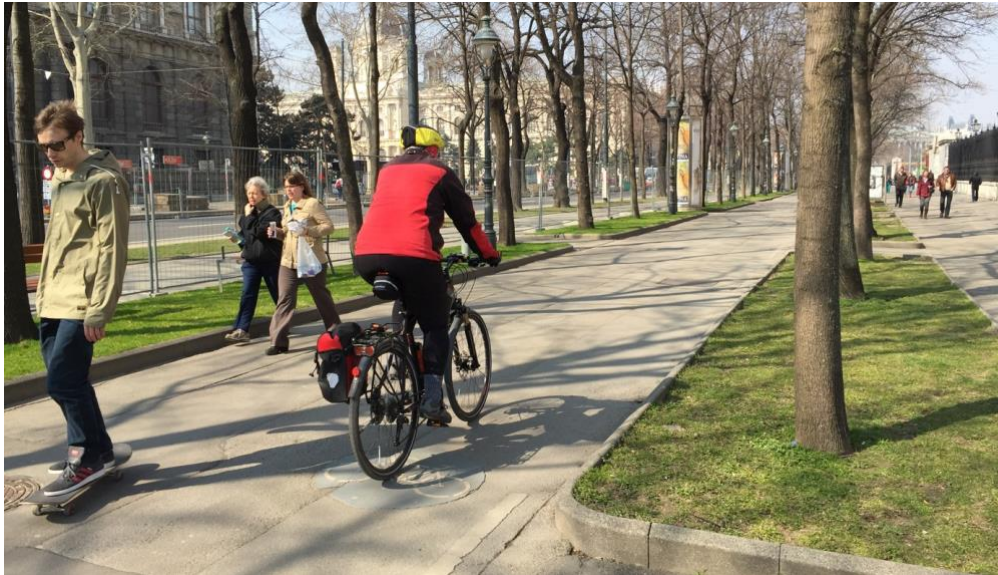


Figure 16-2 Segregated bicycle track in Vienna. Source: [Andrew Nash](#) / [CC BY-SA 2.0](#) / Flickr

16.7 Good practice

The study shows that public transport in Vienna is attractive. The public transport offer of providing an unlimited journey ticket in Vienna for an annual fee of 365 Euros is impressive. The ticket allows the user to make unlimited trips within the core Vienna region, which covers most of the city and the city centre. The ticket does not include trips to the airport.

An annual fee of 365 Euros translates to 1 Euro a day ticket. This offer makes public transport in Vienna attractive from an affordability sense.

17 Madrid, Spain

Madrid, the Spanish capital city, ranks 6th in the overall ranking. The city scored well in road safety and active mobility, average in public transport and below average in air quality and mobility management.

17.1 Modal Share

Madrid has a 26% share of personal motorised modes, 36% of walking and cycling and 38% of public transport use. Hence, collectively sustainable transport modes make up 74%. The city has a density of over 5,000 inhabitants/sq. km, almost the same as London. The high density of Madrid could be a reason for a high share of walking trips.



Figure 17-1 Public space in Madrid with walking and cycling. Source: [Oscar F. Hevia](#) / [CC BY-SA 2.0](#) / Flickr

17.2 Public Transport

Madrid ranks the 6th place in public transport. With 38% share of public transport, Madrid is slightly higher than London. The annual capacity of public transport in Madrid is over 1 bn trips, translating to 334 annual trips per inhabitant of Madrid. The metro in Madrid is the seventh largest in the world and carries around 624 million people a year. Public transport in Madrid is affordable compared to other cities in the analysis. A single journey ticket in Madrid costs 22% of the cost of daily food, while in London the ticket costs 89% of the cost of daily food.

17.3 Road Safety

Madrid scores 4th rank for road safety. In 2016, there was 1 bicycle death and 16 pedestrian deaths. There were also 14 crashes for every 10,000 bicycle trips and 18 crashes for every 10,000 pedestrian trips. While the crash numbers are low, the pedestrian fatalities are serious. If Madrid intends to increase the share of cycling more effort is required in segregating cyclists from motorists and pedestrians. Madrid has the potential to increase its bicycle share if proper effort is put in cycling infrastructure and planning.

17.4 Air Quality

Madrid scores 7th in air quality scoring. The NO₂ concentrations are beyond the EU limit at 44.54 µg/m³/year. The PM₁₀ and PM_{2.5} values are within the EU standard at 20.09 µg/m³/year and 9.8 µg/m³/year.

Furthermore, Madrid exceeds the WHO guideline for air quality in both NO₂ and PM₁₀ concentrations. As for PM_{2.5} concentrations, Madrid is barely below the WHO guideline.

This shows that the city has to invest a great deal of effort into improving the air quality. Compared to the air quality in 2016, the 2017 air quality in Madrid has deteriorated. More stringent regulation is required against polluting vehicles and economic instruments need to be implemented to penalise vehicles that violate regulations.

17.5 Mobility Management

Madrid is tied with Zurich at the 7th place in mobility management. The city has an above average cost of hourly parking, at 35% of the share of a daily food i.e. parking in Madrid is expensive. This is one potential factor for low motorised mode share in Madrid. On the other hand, the city also has a good public transport system and low congestion index value. Both these values denote a less dependence on personal vehicles.

The city also implemented a shared mobility scheme for cars and bicycles. There are 6 shared bicycles / sq. km and 3 shared cars / sq. km.



Figure 17-2 Narrow streets, ideally fit for walking and cycling, filled with parked cars in Madrid. Source: [Martin Stiburek](#) / [CC BY-SA 2.0](#) / Flickr

17.6 Active Mobility

Madrid is tied in the 5th place together with Oslo for active mobility. The score is high because of the high share of walking in Madrid (30%) and a high share of urban green spaces (57.7%). The city also has 3,328 shared bicycles and 195 kilometres of bicycle lanes (segregated and non-segregated combined). With a few kilometres of bicycle lanes a city cannot aim to increase the share of cycling. To be successful in increasing the cycling share, Madrid would need to set an ambitious cycling target and implement projects to achieve the target. When ambitious targets are coupled with quality bicycle infrastructure the share of bicycling will increase, see examples from Amsterdam or Copenhagen.

17.7 Good practice

Madrid's efforts to implement a zero-emissions zone to curb air quality. The city already has car restrictions in the city centre, this will be further strengthened by the zero-emissions zone. By 2025 the city will restrict vehicles without a valid emissions label in the municipal area. The city is also shifting to low emission vehicles for public transport. The newly procured vehicles are the latest EURO standard or electric.

17.8 Areas for improvement

Public transport, air quality and mobility management are areas that need further improvement. Public transport in Madrid have a good amount of ridership and is affordable. Cross-subsidising i.e. charging motor vehicles and using those funds to support public transport and active mobility could be an option.

Providing technological options to attract ridership into public transport is suggested. Using apps to schedule and purchase tickets will enable increase of ridership. The app can also support riders to chain their trips on various modes e.g. using a shared bicycle to reach the bus station.

18 Paris, France

Paris, the French capital city is 3 to 15 times denser than the other cities analysed. The core city of Paris has an urban density of 21,000 inhabitants/sq. km, Paris together with the 3 neighbouring districts (called the Petite Couronne) has a density of 8,652 inhabitants/sq. km. In some indicators (public transport, air quality and shared mobility) we considered the Paris + Petite Couronne region.

Paris ranked 7th in the overall ranking of sustainable mobility performance among the 13 cities analysed. While Paris has a strong ranking in public transport, there is a great scope of improvement in road safety, air quality, mobility management and active mobility.

18.1 Modal Share

The share of personal automobile trips in Paris is the least, with only 15.8% of the trips attributed to individual motor vehicles. Paris also has a pedestrian share of over 41%, a 3% cycling share and a 40 % public transport share³⁰. This means that the overall sustainable mobility share in Paris is 84%.

The share of personal automobiles in Paris remains unchanged since 2010. The mayor's office has implemented various sustainable mobility projects. The impetus for these projects comes from promoting sustainable mobility as a means to improving the deteriorating air quality. The mayor has also publicly announced various plans and many of them are yet to materialise.

18.2 Public Transport

Paris ranked 2nd for public transport, tied with Vienna and Moscow. Paris's rank is mainly due to the current high share of public transport (40%) and an affordable public transport system.

On average, every resident of Paris + Petite Couronne region³¹ makes 517 trips by public transport annually. Paris has about 7 public transport stations every sq. km. of the service region of the public transport. Additionally, a single journey public transport ticket costs about 18% of the cost of daily food, which is below the average affordability rate in the analysed cities, making it more affordable to use public transport in Paris, compared to many other cities in this study.

³⁰ Are area of core city of Paris is very small (only 151 sq. km.) The Paris-Paris trips are about 8 mn/day and the Suburban-Paris trips are about 4.3mn/day. Hence, the actual modal share of Paris cannot be reflected by considering core city of Paris. We took a weighted average of both the Paris-Paris and Suburban – Paris trips.

³¹ As mentioned earlier, the city of Paris is a part of a larger transport network, that carries over 67% of trips to Paris.

In absolute terms, the public transport system in Paris carried about 3.4 bn people in 2016, this is the 3rd highest annual capacity of a public transport system in the study. The first two being London (3.99bn) and Moscow (3.58 bn).

18.3 Road Safety

Paris ranks 9th in road safety. In 2016, Paris had about 23 pedestrian fatalities and 3

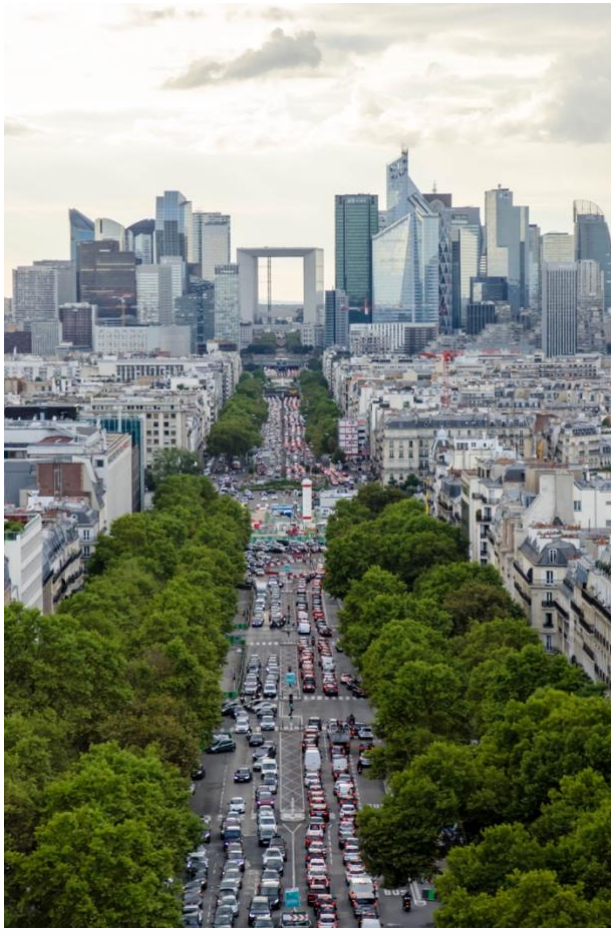


Figure 18-1 Paris arterial filled with cars.

Source: [Tiffany](#) / [CC BY-SA 2.0](#) / Flickr

bicycle fatalities. In terms of crashes there were 113 bicycle crashes for every 10,000 bicycle trips, making cycling a dangerous task in Paris. This explains the very low modal share of cycling (3%). On the contrary, there were 19 pedestrian crashes for every 10,000 walking trips, denoting that walking is safer than cycling in Paris. Walking in Paris also represents 41% of the trips in the city. This means that there are more pedestrians to be found on the streets of Paris than cyclists.

18.4 Air Quality

Paris ranks 12th in air quality. The annual mean of NO₂ concentrations in Paris is 49.56 µg/m³, a value that exceeds the EU limit. The annual means for PM₁₀ and PM_{2.5} are within the EU standards. The PM₁₀ and PM_{2.5} annual mean values for Paris are at 26.87 µg/m³ and at 16 µg/m³, respectively.

Paris exceeds the stricter WHO guidelines in all categories. This denotes

that the bad air quality in Paris is an unseen and potential threat to public health. A high concentration of particulate matter is extremely dangerous for humans and causes respiratory illnesses and long-term exposure can lead to death.

In the new climate, air and energy action plan, which Paris adopted beginning of 2018, the mayor expressed intention to get rid of diesel vehicles by 2024 and of petrol vehicles by 2030. In 2015, the mayor also has also expressed intention to reduce the NO₂ and PM values by 40% and 20% respectively by 2020. There are some actions in place like pedestrianising some streets, banning heavy polluting vehicles

etc. Paris also has to work more in relationship with the Great Paris area towards a reduction of the flow of individual cars in the whole region.

18.5 Mobility Management

In mobility management Paris ranked 9th rank among the 13 cities analysed. The cost of hourly parking on an average is about 38% of the share of the cost of daily food in Paris. There is also a 38% increase in travel time due to congestion, denoting a high motor vehicle use.

The score of Paris could be improved if the city were to implement higher parking prices; smartphone apps for ticketing, as one already exists for scheduling; implement a congestion charge or a similar fiscal instrument to curb air pollution; have more availability of car sharing in the service area (which extends the core Paris city). Extending shared mobility and promoting safe bicycle infrastructure could increase performance of Paris in the scoring.



Figure 18-2 Velib - the bike sharing system in Paris, with most of the docks full. Source: [Kate Foy](#) / [CC BY-SA 2.0](#) / Flickr

Although Paris seems to have the highest number of shared bikes in the system (14,500 bikes), the area of service is over 760 sq. km. An observatory established to monitor³² the results, delivered by the leadership in Paris on bicycling infrastructure in the city, reports that there is a lack of progress in provision of bicycling infrastructure in the city.

18.6 Active Mobility

Paris has about 44% of active mobility share (of which 41.3% is walking trips) and 21.5% of urban green cover³³, giving Paris the 4th rank. The high walking share in Paris can be attributed to the high density in the core Paris city (over 21,000 inhabitants/sq. km). Cycling contributes only to a 3% share in active mobility, which is

³² <https://parisenselle.fr/observatoire-du-plan-velo/>

³³ a high green cover encourages leisurely activities and walking

low for a city with such a high density. To increase the share of cycling, Paris needs to work on road safety issues and have dedicated infrastructure for cycling.

18.7 Areas for improvement

Paris has a high scope for improvement in air quality, cycling and road safety. Paris already has a high share of public transport and integrating public transport with other modes – especially cycling – and increasing the access to public transport could enable a shift to public transport and reduce air pollution.

To improve air quality, Paris needs to implement stringent air quality standards for automobiles. Implementing strict low emission zones and traffic free area will deter use of cars and encourage use of public transport. While there have been statements from the leadership to restrict automobile and even remove fossil fuel vehicles off the streets of Paris, it remains to be seen whether the statements will turn to reality.

The city of Paris is a part of the Greater Paris region (Ile-de-France) and the mobility patterns in Paris are influenced by the mobility choices of inhabitants in Greater Paris. To be successful, car restraint measures and sustainable mobility policies in the city of Paris need to be inline larger mobility plan of the region. An integrated mobility policy for the region will benefit both the city of Paris and the region.

19 Brussels, Belgium

Brussels - in the study it is the Brussels capital region - has ranked 8th in the overall rank for sustainable mobility performance. The area covered is 161.38 sq. km, with a population of 1.17 million inhabitants, giving the region a density of 7,282 inhabitants/sq. km.

19.1 Modal Share

Brussels has about 44% of personal motorised trips, the third highest share in the cities we analysed. We presume that majority of these trips arise from commuters and the lack of quality public transport.

The high motor vehicle use could also be an outcome of cheap parking and easy access to a car than public transport. Other factors that could influence personal automobile use is easy access to a car e.g. car provided by the employer, multiple car ownership, higher income levels etc.

19.2 Public Transport

Brussels ranks 11th in public transport, with a 28% share of trips on public transport. The annual number of passengers carried by public transport in Brussels is approximately 370 million. That is, every resident of Brussels makes approximately 314 trips per year.

The low share of public transport can also be due to reduced access to public transport stations. The station density in Brussels is low with about 2.55 stations/sq. km. Hence, the low annual trips/capita. In other words, people living closer to a public transport station tend to use public transport than people far away. We find that the cost of public transport is affordable compared to other cities in the analysis. The cost of a single journey public transport ticket in Brussels is about 24% of the cost of daily food, which is affordable in comparison to other cities analysed.

19.3 Road Safety

Brussels scored the 10th rank for road safety. In 2016, two cyclists and 10 pedestrians lost their life in Brussels, in the same period there were 221 bicycle crashes for every 10,000 bicycle trips and 38 pedestrian crashes for every 10,000 pedestrian trips. The low share of cycling (3%) can further dwindle because of a hostile cycling situation in Brussels. Effort is required to make cycling safer, by possibly segregating bicycles from motorised traffic and widening the cycling lanes to avoid collisions between bicycles.

19.4 Air Quality

The data shows that Brussels is tied with Zurich, Vienna and Copenhagen at 2nd place for air quality. Brussels has been in the media recently for providing free public

transport to curb high air pollution. This led to us carefully analyse the result of Brussels in this scoring. Data collected shows that Brussels did not have any data reported in 2017 for a monitoring station 41B008 – *Bruxelles (Rue Belliard)*. Data between 2013 – 2016 shows that this station reported values higher than the EU limit. In 2016 the station had an annual mean value of $54 \mu\text{g}/\text{m}^3$. If we use the 2016 data for this station Brussels would then score 4th place instead of the current 2nd.

With regards to PM_{10} ($18.96 \mu\text{g}/\text{m}^3$) and $\text{PM}_{2.5}$ ($13.93 \mu\text{g}/\text{m}^3$) both the annual mean values are below EU limits. The $\text{PM}_{2.5}$ annual mean value for Brussels exceeds WHO guidelines. The WHO guidelines employ a stricter limit than the EU limits.

A high $\text{PM}_{2.5}$ value is dangerous for public health and long-time exposure and inhalation of these pollutants can cause respiratory illnesses and death. As we mentioned in the air quality section of this report, active mobility users have higher doses inhalation and motorists have a high dose of exposure to pollutants. Hence, the high $\text{PM}_{2.5}$ emission is equally (or even more) harmful to motorists.

19.5 Mobility Management

Brussels ranks 11th for mobility management tied with Budapest. Hourly parking in Brussels costs about 23% of the cost of daily food, and a single public transport ticket 28%, giving an economic incentive to drive. Brussels started their Low Emission Zone in January 2018, it is expected that the LEZ could reduce the air pollution in the city.

Further, the public transport system does not have comprehensive smart phone apps i.e. an app where one can purchase a ticket and schedule the trip. The travel time increase due to congestion in Brussels is 38% which is higher than the average. We presume that the high motorisation is due to high parking affordability, lack of extensive public transport network and high number of trips originating from outside the Brussels region.

19.6 Active Mobility

Tied with London, Brussels ranks 9th in the active mobility category, with a walking and cycling share of 28% and an urban green cover of 33%. The city has also implemented a bike sharing scheme with over 5,000 bicycles. The city is yet to get traction on increasing their bicycle shares. Although the city has a good score for bike share density, 33 bikes/sq. km. an already high motorisation coupled with lack of bicycle safety does not encourage the use of shared bicycling.

The data shows that Brussels has about 154 km of bicycle lanes (both segregated and non-segregated combined), which is low than the average for the cities we analysed. If the city is serious about increasing its bicycle shares more effort is essential to increase the infrastructure for cycling make cycling and walking safe.

19.7 Areas for improvement

Air quality, public transport, road safety and cycling are the areas that need further attention for Brussels to improve its performance.

Although Brussels ranks high in air quality, as we mentioned in the air quality section, Brussels does not report air quality from all the stations. Media reports and EU warnings to Brussels suggest that the urban air quality of Brussels is below the standard. To improve air quality the city needs to be strict with fossil fuelled vehicles. The city has started a low emissions zone from January 2018. The results are yet to come out on the effectiveness of the zone.

Road safety and cycling improvement are interdependent. The low share of cycling in Brussels can be improved by making cycling safer through dedicated cycling infrastructure. Segregating cyclists through dedicated grade-separated³⁴ bicycle lanes from motorists and pedestrians make cycling safe.

Public transport supports a large shift from motorised modes as the system has a potential to carry more people than personal motorised modes. Increasing the area of coverage of public transport by creating a public network in the city, reducing the cost of public transport through cross-subsidies³⁵ and integrating the various public transport modes can encourage the use of public transport.

³⁴ Using different heights for pavement/footpath and bicycle paths, such that the bicycles cannot ride on the pavement or the pedestrians do not encroach the bicycle lanes.

³⁵ Charging motorists and using the revenues to improve public transport.

20 Budapest, Hungary

Budapest, the Hungarian capital, ranked 9th in the scoring. The city has ranked well in public transportation and scored below average in other categories.

20.1 Modal Share

Budapest has a 48% modal share of public transport and 31% of personal motorised modes. The city was traditionally oriented towards public transport system and has retained its infrastructure favouring trams and trolley buses. The data also shows that the city has 2% of cycling and 19% of walking.

20.2 Public Transport

Tied with Vienna, Budapest ranks 2nd in the public transport category, tied with Vienna and Paris. Budapest has a firm public transport infrastructure in trams and metro. The result of which is that the current system in Budapest carries about 1.8 bn people annually. This means a resident of Budapest makes 1037 trips annually, this is the second highest annual trip per capita in the scoring. The station density in Budapest is only 1.25 stations / sq. km, we presume that the stations are located in high density areas, as we see that there are around 30 stations per 100 inhabitants³⁶. Further, public transport costs 29% of the share of a meal in Budapest.

The city still has 31% of trips by motorised modes, the reason for this high share of motorised modes, we presume based on experience, is that the motorists have a higher income level and are not “tied” to using public transport due to economic reasons. It is also likely that the motorists have an easy access to a motor vehicle i.e. car provided by the employer or multiple motor vehicle ownership.

20.3 Road Safety

The road safety data available for Budapest is from 2015. Based on this data, Budapest is in the 8th place for road safety. Budapest has 2 bicycle fatalities and 17 pedestrian fatalities. There were 66 bicycle crashes for every 10,000 bicycle trips and 12 pedestrian crashes for every 10,000 pedestrian trips. With an already low bicycle share (2%) the high share of bicycle crashes can threaten any bicycle promotion activities that do not address the poor road safety.

20.4 Air Quality

Budapest is tied in the 8th place for air quality with Berlin, London and Rome. The annual mean of NO₂ concentrations (44.801 µg/m³) in Budapest exceeds the EU limit. This could be due to the high number of diesel motor vehicles, or older petrol vehicles with lower Euro standard.

³⁶ Calculated by using the urban density of Budapest

The PM₁₀ annual mean is at 10 µg/m³, which is within the EU limit and the PM_{2.5} value is at 25 µg/m³ which is just meeting the EU limit.

Budapest exceeds the WHO guidelines for NO₂ and PM_{2.5} and is below the WHO guideline limit for PM₁₀ concentrations. The PM_{2.5} values in Budapest (25 µg/m³) are more than 100% of the WHO guideline limit (10 µg/m³). The high PM_{2.5} can be a health concern as the particulate matter 2.5 is very small and can cause serious respiratory problems in people.

20.5 Mobility Management

Budapest is tied with Brussel at the 11th rank in mobility management. An hour of parking in Budapest costs the same as a single journey public transport ticket. In both cases a user would spend about 29% of the cost of daily food. This situation encourages people who own a car to drive rather than use the public transport which presumably takes more time to reach the destination.

The travel time lost due to congestion in Budapest is the least with only 22%, this could mean that the number of motor vehicles in Budapest is still low and can be tackled with proper demand management measures.

With no fiscal instrument to control the use of personal automobile and lack of a smartphone app where users can both buy a ticket and plan a journey, driving an automobile is more attractive.

20.6 Active Mobility

Budapest ranks 11th in active mobility. The share of bicycling and walking are low compared to other cities in the analysis. Together walking and cycling make 21% of the trips. Budapest also has a 35% urban green cover, which means that 35% of the city spaces are green. The newly introduced bike sharing scheme is in the beginning stage with around 1500 bicycles. The low cycling share and unsafe conditions, do not raise expectations that bicycle sharing will change the face of cycling in Budapest, unless road safety is increased for cycling and automobile restrictive measures are implemented.

20.7 Good practices and areas for improvement

Public transport is a strength in Budapest. The traditional public transport system that is rail based and the trolley buses have a great potential to carry large number of people. Modernising public transport will attract new riders.

As the current levels of motorisation in Budapest are still manageable, a regulatory instrument to control the entry of motor vehicles in the city centre and a fiscal instrument to penalise polluting motor vehicles can be put in place. Such an instrument can both discourage private motorised trips and also generate revenue that can be used to develop public transport and active mobility.

21 Berlin, Germany

Berlin is known for its innovation in urban mobility, electric mobility and comprehensive public transport. In the current ranking Berlin ranked 10th in the overall sustainable mobility performance. Berlin scored well in active mobility, average on mobility management and scored on the lower end for public transport, road safety and air quality.

21.1 Modal Share

Berlin has a share of about 30% personal automobiles (cars and motorised two wheelers). The high share of personal motor vehicles could be due to the large size of the city and the poor performance of the public transport. The urban density for Berlin is 4,116 inhabitants/sq. km. Some cities with similar urban densities (e.g. Vienna, Zurich, Amsterdam) have better public transport and active mobility compared to Berlin.

Berlin adopted the Sustainable Urban Mobility Plan (SUMP) in 2011. The motorised transport share between 2008 and 2013 has reduced only 0.3% per year. Further, there is no documented evidence of the modal share in the city after 2013. Hence, it is difficult to obtain the current status of the personal automobile share.

21.2 Public Transport

Despite having an extensive public transport network, Berlin was unable to score high points in this category. Berlin ranked 12th among the 13 cities analysed. In terms of annual per capita trips i.e. a resident of Berlin typically uses the public transport 322 times in a year. With a public transport share of 27%, Berlin has approximately 9 public transport stations/sq. km.

Berlin scored low in public transport affordability, in Berlin a single public transport ticket costs 2.80€. The cost of the ticket is approximately 36% of the cost of daily food, making it slightly expensive than the average affordability value among all the cities. Rome, having 29% public transport trips and a very low annual trips per capita, and to our surprise, ranked higher than Berlin. The cost of a single public transport ticket in Rome is 18% of the cost of daily food, compared to Berlin's 36%, giving Rome the extra points to score higher.

21.3 Road Safety

Berlin scored very poorly on road safety, giving it 11th place. The city has a high share of accidents to pedestrians and cyclists among the 13 cities analysed. Berlin has 163 bicycle crashes for every 10,000 bicycle trips and about 22 pedestrian crashes for every 10,000 pedestrian trips. The share of fatalities among bicyclists is also high at 15 bicycle fatalities in 2016 and pedestrians is at 17 fatalities in 2016. Berlin has the second highest bicycle fatalities in the scoring.

Berlin has 13% share of cycling trips and 31% share of walking trips and such a high share of accidents and fatalities to cyclists could further plummet the current bicycling shares (Pucher, 2017).



Figure 21-1 Lack of physical segregation in Berlin could lead pedestrians onto cycle paths. Source: Santhosh Kodukula

Berlin, and other cities aiming to increase bicycle shares, could benefit from using the Dutch or Danish bicycling design example and physically segregate bicycles and motorised traffic. The high share of bicycle fatalities denote that the bicycle collisions are mainly with motor vehicles. By having physical segregation bicycle will be made safer. A similar recommendation applies also for increasing the safety for pedestrians.

21.4 Air Quality

Berlin ranked 8th in air quality, tied with London, Rome, and Budapest. The annual mean NO₂ levels (47.147 µg/m³) are beyond the EU limit. The PM₁₀ values for Berlin (25µg/m³) though are below the EU limit they are higher than most of the cities analysed. Similarly, the PM_{2.5} concentrations, which are more harmful, are at 17 µg/m³ and within the EU limit.

Berlin exceeds the WHO guidelines in all the pollutant categories viz. NO₂, PM₁₀ and PM_{2.5}. The high particulate matter and NO₂ concentrations pose a serious and unseen public health risk to the inhabitants of Berlin. Berlin could greatly benefit from controlling the NO_x pollutants – i.e. both NO₂ and NO – and from introducing vehicular bans for highly polluting vehicles esp. internal combustion engines. The city could also benefit by introducing more stringent environmental zones within the city.

21.5 Mobility Management

Berlin scores 5th rank in the mobility management category. The data shows that parking in Berlin is more affordable than riding public transport. A user would pay 28% of the cost of daily food for an hour of parking, while the public transport costs about 36% of the cost of daily food. It also has to be noted that residential on-street parking in Berlin, and many German cities is either very cheap or free. Similarly, many streets of Berlin allow free on-street parking. The cheap or free parking is an incentive to drive in Berlin. The congestion index shows that in Berlin there is an increase of 29% of the trip time when driving due to congestion. This is below the average travel time loss and a potential incentive for driving in Berlin as the time loss is not as severe in Moscow or Rome where more than 40% of the travel time is lost due to congestion.

In terms of accessibility of shared mobility, Berlin has about 3 shared cars / sq. km in the city and about 7 shared bicycles / sq. km. The car sharing accessibility is higher than the average of the 13 cities and bike sharing accessibility is lower than the rest.

21.6 Active Mobility

From the analysis Berlin scored the 3rd place for active mobility. The main reason for Berlin's success over many other cities, is that it has a high share of active mobility esp. walking which is about 31% and cycling which is 13%. Berlin also has about 40% of urban green cover and the third highest number of shared bicycles (6,188 bikes).



Figure 21-2 Cyclists need to compromise for road space with motor vehicles in Berlin. Source: Santhosh Kodukula

It seems to be that there is a strong penchant among Berliners to bicycle, as the city has experienced a growth in cycling since 1992. As argued earlier any attempt to increase bicycling should go hand in hand with increasing the safety for the cyclists As the growth in cycling can be sustained only when the mode is considered safe (Pucher, 2017).

21.7 Good practice

Smart mobility has been a strength in Berlin. The city has been at the forefront to adopt smart technologies and mobility options such as car sharing. Converting public transport vehicles to electric and with wireless charging was experimented in Berlin (more information: <http://www.emo-berlin.de/>).

21.8 Areas for improvement

With a high air pollution share, Berlin would benefit from introducing a fiscal instrument to deter automobile use, something similar to congestion pricing or road pricing, which will target the heavily congested streets.

Berlin also needs a strict parking management system. Like in many German cities, Berlin provides parking on many streets at no cost. A city-wide parking management is essential in Berlin. Similarly, residential parking is heavily subsidised and residential

parking permits are generously issued for a low cost. A pricing strategy that will revise the existing low cost of residential parking is required in Berlin.

In terms of cycling, there seems to be a public interest to bicycle, shown by the increasing cycling numbers. If favourable conditions are created for cyclists the share of cycling can further increase. Provision of segregated bicycle tracks, instead of painted cycle lanes in motorised traffic will increase the safety of cyclists. The house of representative in Berlin will take a decision in mid-2018 to a proposal by the Berlin government to promote cycling. Such a proposal if approved by the house will benefit the cyclists as more resources will be allocated for cycling infrastructure and safety.

Bicycle superhighways, as with the Copenhagen model, can also be adopted for Berlin. This would enable cyclists to move at a higher pace without interacting with cars.

22 London, United Kingdom

London, the capital of England and United Kingdom, is a historic city and has been a centre for great transformations for over two millennia. It is a global city and one of the important financial centres of the world. Overall, London ranks 10th for sustainable urban mobility performance among the 13 cities analysed. London ranks well in mobility management practices, average in public transportation, below average in active mobility, and poor in road safety and air quality.

22.1 Modal Share

With a population of 8.8 million inhabitants, London spreads over 1.572 sq. kms, giving her a density of 5,590 inhabitants/sq. km. London has the 4th highest urban density among the cities analysed. London has a 37% share for trips on personal automobiles.

The size of the London could be a reason for increased trips by personal automobiles. While the core of the city is expensive for residential use, people tend to locate in the outer periphery of the city and commute to the city.

In the recent years, the current Mayor of London and the former mayor have shown significant determination in promoting sustainable mobility. The emissions charge (or the T-Charge) introduced by the current mayor Sadiq Khan aims to deter the use of old and polluting vehicles into the centre of London, the zone that already implements the congestion charge.

22.2 Public Transport

London scores the 7th place in public transport, tied with Madrid. Although, the city has an extensive public transport infrastructure, the annual trips per capita for London is 454 i.e. every inhabitant of London takes the public transport 454 times in a year. The city has approximately 12.4 public transport stations per sq. km.

The cost of public transport in London is 89% of the cost of daily food, making it the most expensive in the analysis. In absolute numbers the annual capacity of public transport in London is almost 4 billion trips per year the second highest in the 13 cities analysed, yet the number of trips made by its citizens is less than the average, due to the spread of its population.

22.3 Road Safety

London has a very large scope for improvement in the road safety situation. In the analysis London ranks 12th in road safety or 2nd most unsafe city to walk or bicycle. London had 8 bicycle fatalities, third highest, and 61 pedestrian fatalities in 2016, the second highest in the analysis. The high number of fatalities in bicyclists and pedestrians denote that the collisions were likely with fast moving motor vehicles. Additionally, the city had 251 bicycle crashes for every 10,000 bicycle trips, and 26

pedestrian crashes for every 10,000 pedestrian trips. We deduce that the high share of bicycle crashes are also ones involving motor vehicles. This is because the share of bicycling in London is only 2% and 37% of motorised trips.

London has developed strategies, such as speed limits and awareness campaigns, to reduce the number of accidents and fatalities for cyclists and pedestrians. These strategies are further defined in the Safe Streets for London strategy³⁷ and also in the Cycling Safety Action Plan³⁸.

22.4 Air Quality

London ranks 8th in terms of air quality of the 13 cities analysed. London is tied with Berlin, Rome and Budapest. The annual mean NO₂ values in London are beyond the EU limit at 50.8 µg/m³. The PM₁₀ values (19.4 µg/m³/yr.) and PM_{2.5} values (12.4 µg/m³/yr.) are within the EU limits.

London exceeds the WHO guidelines for NO₂ and PM_{2.5}. The PM₁₀ value for London is just below the WHO guideline.

The NO₂ and PM_{2.5} concentrations are harmful for the environment and public health. It is expected that NO₂ and particulate matter can be abated through policy measures such as the T-Charge or the emissions charge on vehicles entering the central London area. The previously implemented congestion charge has proven to reduce emissions to some extent.

A fiscal instrument such as T-Charge is certainly beneficial to reduce the emissions, the current implementation area is limited to the existing congestion charging area. To be more effective the T-Charge area could be larger than the congestion charging zone, to avoid the effects plateauing after a certain period.

22.5 Mobility Management

London scored very well in mobility management compared to the other cities. London received a 2nd rank for mobility management. The reason for London's success is from the visionary congestion charging scheme and the high cost of hourly parking. The cost of hourly parking in London is about 5.60 € which is about 80% of the share of the cost of a meal in London. Yet, it has to be noted that the public transport is slightly higher than parking, making parking more affordable, resulting in more motorised trips as motorists would think of trip chaining.

22.6 Active Mobility

With a share of 24% walking, 2% cycling and 33.5% urban green cover, London scores 9th rank in the active mobility category. The city has also implemented a bike sharing

³⁷ <https://tfl.gov.uk/corporate/safety-and-security/road-safety/safe-streets-for-london>

³⁸ <http://content.tfl.gov.uk/cycle-safety-action-plan.pdf>

system with over 11, 500 bicycles, the second highest of the cities ranked. Plans and projects are in place to encourage walking and cycling through increased safety.

22.7 Good practice

London has been the leader in the west to charge motor vehicles to enter the city centre. The Congestion charge has been an inspiration to other cities such as Stockholm and Milan. Many cities contemplate to implement such a scheme and refrain due to weak political will. By introducing the T-Charge, London has taken the commitment to clean air to a higher level. The high cost of parking in London is also a good practice for other cities in the region to follow.

22.8 Areas for improvement

While it is a herculean task to shift motorist behaviour, concrete policies such as the congestion pricing could be expanded. While congestion charge and T-charge are good practices, the area of implementation of these charges still leaves a greater leeway for motor vehicles and contribute to higher emissions. London could implement a road pricing system as Singapore, where motor vehicle users on all streets of London have to pay for using the road. The road price shall be dynamic depending on the congestion on the street and the air quality on the street. Such an air quality based road pricing would be innovative and put London again in the forefront of making motorists pay (almost) the real costs of their travel.

23 Moscow, Russian Federation

Moscow, the Russian capital is the most populous city among the cities in the current analysis. With a population of 12.2 million people in its 2,511 sq. km, Moscow is also the largest city in area in the analysis. The urban density of Moscow is 4,870 inhabitants/sq. km.

Moscow scored the 12th rank. Moscow has performed average in public transport and mobility management, below average in road safety and poor in air quality and active mobility.

23.1 Modal Share

According to the published modal share results available online, from 2010, the personal automobile share was 45%. Although several media reports point to the impressive effort of the city of Moscow in promoting public transport and shared mobility, no concrete numbers were available for the modal share hence the analysis was made with the available figures from 2010.

23.2 Public Transport

Moscow ranked 2nd in public transport. Moscow has a historic metro system that began in 1935. Together with the bus and tram network the entire public transport system in Moscow carried 4.78 billion people in 2016. In spite of being a highly populated city the annual trip per capita of Moscow's public transport system is only 293 trips/person/yr. The low trip per capita could be a result of the low station density in Moscow. This is a very low density compared to other high performing cities in the analysis. London which carries close to Moscow's annual capacity has 12.4 stations per sq. km. It can also be inferred that Moscow has a great potential to move more people if the public transport stations are more accessible to people.

Further, the public transport in Moscow costs about 13% of the cost of a daily food making journey by public transport very affordable. Yet, the lack of an expansive public transport network contributes to a high use of personal automobiles.

The high score for Moscow is mainly due to its affordable public transport system, high share of public transport.

23.3 Road Safety

Moscow scored the 7th place for road safety. Moscow had 232 pedestrian fatalities in 2016, the highest in the analysis, and 5 bicycle fatalities. Similarly, there were 92 crashes for every 10,000 bicycle trips and 5 crashes for every 10,000 pedestrian trips. The high share of bicycle crashes and pedestrian fatalities denote a hostile environment of walking and cycling. This is also represented by the low walking and cycling shares in the city. The high share of fatalities in pedestrians also points that the accidents might be caused by high speed motorised vehicles.

23.4 Air Quality

Moscow ranked last in air quality. The air quality data for Moscow was collected from the official open data portal. The annual mean NO₂ values for Moscow is 66.910 µg/m³, which exceeds the WHO standard (which is also the EU limit). The PM₁₀ and PM_{2.5} values at 46.770 µg/m³ and 28.63µg/m³, also exceed the WHO standards³⁹.

The poor air quality in Moscow can be from high number of motorised vehicles on the roads, and growing number of fossil fuel powered cars that result in severe air pollution.

23.5 Mobility Management

Moscow ranks 5th for mobility management. The city has a 44% of travel time increase due to congestion making it the most congested city among the 13 cities. Hourly parking in Moscow costs about 108% of the cost of daily food, yet there is a high personal motorisation, leading to an assumption that the pricing of parking might be too low, or the lack of an expansive public transport network drives people to use their personal automobiles. It is also possible that motor vehicle represents a social status or the access to a motor vehicle is easy, either from the employer or due to multiple vehicle ownership.

In order to move away from excessive motorisation, Moscow needs to charge the true costs on the automobiles and make travel by public transport affordable, reliable and attractive.

23.6 Active Mobility

No concrete figures for active mobility were available for Moscow for cycling and walking individually. An overall figure of 6% was mentioned for active mobility. The protected areas of Moscow that we can call green cover accounts for 7.03%, however, reliable data for additional green cover is not available. Based on the values of active mobility Moscow ranked 13th in our analysis.

The city has implemented bike sharing scheme. There are about 3,750 bicycles in the city for use. Considering the size of Moscow and its population, the number of shared bikes available might be too low to see a rise in cycling.

23.7 Good practice

Several media reports and presentations from the city officials have shown impressive projects being implemented by the city of Moscow to advance shared mobility and public transport. The city is investing in expanding its metro rail and

³⁹ WHO guidelines for NO₂ Annual mean is 40 µg/m³; for PM₁₀ is 20 µg/m³/yr.; for PM_{2.5} is 10 µg/m³/yr. WHO standards for air quality are stringent than the EU standard for PM₁₀ and PM_{2.5}.
[http://www.who.int/en/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](http://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)

creating a circular route that will increase access to public transport users. There are also reports of wide spread car sharing implementation as a means to deter people from driving their personal car.

Moscow has also implemented electric car sharing system, as of January 2017 there are about 281 electric cars in Moscow⁴⁰. The announcement from the city leadership to have 200 electric car charging stations by the end of 2017 did not materialise. A study by Greenpeace in Moscow found that of the 77 stations available in November 2017 many were malfunctional or dismantled⁴¹.

23.8 Areas for improvement

While there is no reliable data for walking and cycling, our recommendations are based on the 2010 modal split data and the road safety data we obtained from 2016.

Moscow has a great deal to improve on the road safety front. The pedestrian fatalities number in Moscow is almost 4 times that of London which has the second highest pedestrian fatalities in the scoring. We presume that the high pedestrian fatalities number is due to excessive motor vehicle speed on the streets of Moscow. In order to improve the road safety situation, we recommend reducing the urban road traffic speed to be 30 km/h and 20 km/h or lower in residential areas. Increasing road safety in Moscow, along with dedicated cycling infrastructure will be beneficial for both the pedestrians and cyclists.

⁴⁰ <https://www.autostat.ru/news/29517/>

⁴¹ <http://www.greenpeace.org/russia/ru/news/2017/air-1123/>

24 Rome, Italy

The Italian capital city, Rome ranked 13th in the urban mobility ranking. The city ranked poorly in road safety, mobility management, and active mobility; and below average in air quality and public transport.

24.1 Modal Share

Rome has the highest share of personal automobiles at 65%, a mere 1% of cycling, 6% of walking and 29% of public transport trips. The city does not yet have an approved sustainable urban mobility plan (SUMP) and is currently in the consultation phase of implementing a SUMP. We believe that the preparation of SUMP is also due to the mandatory requirement of a SUMP by the national government.

24.2 Public Transport

Rome ranked 8th in public transportation. The city has a 29% modal share for public transport and the system carries approximately 935 million people annually. This translates to 325 trips per inhabitant of Rome. While public transport is affordable in Rome, costing about 18% of the share of a meal, a lack of attractiveness of public transport and dominance of automobile friendly infrastructure and policies discourage the use of public transport. The high share of motorised two-wheelers (15%) also contribute to the low share of public transport as the motorised two-wheelers reach destinations that are otherwise unreachable by public transport.

24.3 Road Safety

Rome ranks 13th in road safety. The city has 25 bicycle fatalities and 47 pedestrian fatalities in 2016. During the same time period there were 110 crashes for every 10,000 bicycle trips and 133 crashes for every 10,000 pedestrian trips. With an already frail share of cycling, the high fatalities and crashes to cyclists will contribute to dwindling numbers, unless effort is put into making cycling and walking safe.

24.4 Air Quality

Rome is tied with London, Berlin, and Budapest on the 8th spot for air quality. The NO₂ values (49 µg/m³) exceed the EU limit. This is a result of the high share of motorised trips. The worsening air quality can take a toll not only on the public health but also on the historic architecture of the city which is one of the main attractions for tourism in Rome. We haven't calculated the monetary value of the effect of air quality on architecture and heritage, we presume this number to be high if it were to be computed.

The PM₁₀ and PM_{2.5} values are within the EU limit at 28 µg/m³/yr. and 17 µg/m³/yr., respectively.

Rome exceeds the WHO guidelines for NO₂, PM₁₀ and PM_{2.5}. The high shares of these pollutants demand for solutions that abate the pollution levels. If such high pollution continues in the city the inhabitants of the city will be facing a serious public health hazard from air pollution.

24.5 Mobility Management

Rome ranks 13th in the mobility management category. The cost of parking in Rome is about 12% of the cost of daily food. This means that parking for one hour is more affordable in Rome than a single journey ticket. Rome also has a central zone restricted to cars, this restriction is time bound and not a permanent restriction. This is a rather weak implementation compared to a permanent vehicle restriction in the city centre.

Rome also has 40% increase in travel time due to congestion, denoting a high amount of automobile use. Although the city has implemented bike and car sharing schemes the availability of the modes is very less. There are about 1 shared car or shared bike every sq. km. of Rome.

24.6 Active Mobility

Rome scored 12th place in active mobility. This is largely due to a very low walking and cycling mode share. Together they constitute to 7% of the modal share. The city has over 68% urban green cover and has also introduced bike sharing scheme with about 1,200 bicycles. The data also shows that the city has about 100 bicycle paths/lanes (segregated and non-segregated). With such a low share of cycling and no extensive cycling network, the current shares of cycling will reduce if no effort is put into providing quality and safe cycling infrastructure.

24.7 Areas for improvement

Considering that Rome intends to increase its share of bicycling, our recommendation is that the city invests more in infrastructure that segregates bicycles from motorised modes, especially motorised two wheelers. See the case of Amsterdam where there was a regulation to remove scooters in favour of bicycles.

Rome has a large scope to restrict personal automobile by implementing pricing schemes. The project in Milan "Area-C" can be an immediate inspiration for Rome as it is from the same country. If Rome wants to look for international examples, experience from London and Stockholm are readily available.

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GREENPEACE

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It needs solutions. It needs change. It needs action!