International Transport Forum

Road Safety in European Cities

Performance Indicators and Governance Solutions

Case-Specific Policy Analysis

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The International Transport Forum

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Executive summary

What we did

This reports benchmarks road safety performance in 72 urban areas, mostly in Europe, and illustrates governance solutions to improve urban road safety with case studies conducted in Lisbon (Portugal) and Riga (Latvia). The report proposes new road safety indicators to assess the level of risk for each mode of transport. Data for 31 administrative perimeters collected directly from local governments. Of these, 19 are in Europe, ten in the Americas and two in Oceania. Data for a further 41 functional urban areas (FUA) in Europe were gathered from national and European sources. A network of road safety experts was developed to support the data collection and to share experiences with road safety analysis and policy making. Members of this network met for five rounds of discussions between April 2017 and November 2018 within the framework of ITF's Safer City Streets initiative. Additional stakeholder interviews and desk research were conducted to outline the role of specific policies and governance frameworks, to highlight practical solutions and to make recommendations for improving urban road safety.

What we found

Considerable differences in fatality risk for road users exist between cities, and much can be learned from cities which have successfully in lowered this risk. Yet counting fatalities may not tell the full story of a city's road safety performance. In addition, fatalities are challenging to analyse statistically because of the relatively small numbers at the municipal level. For these reasons the analysis of traffic injury data is also important. However, injuries sustained in traffic crashes remain notoriously under-reported, and different metrics are used to score their severity in different places.

Pedestrians, cyclists and motorcyclists are the most vulnerable road users; they make up about 80% of road fatalities in dense European urban areas. Non-motorised road users face a fatality risk almost ten times greater than the risk for car passengers for a given distance travelled in cities. Yet car traffic creates a far greater risk for third parties involved in crashes. Modal shift away from private motor vehicles could significantly improve road safety in dense urban areas. It would also bring public health benefits associated with increased physical activity and improved air quality. Areas where people cycle the most also have the lowest total road mortality.

Major road safety problems result from policies which have created car-dependent communities. These are often the effect of urban sprawl, fuelled by lacking integration of land-use and public transport planning at metropolitan level. Car-dependent communities generate large traffic volumes and therefore large risks. They also tend to resist policies addressing traffic volume and car speeds, since they have very little alternative mobility options.

Two examples of cities where road safety has not been a political priority and where there is large room for improvement are Lisbon and Riga. Both cities are confronted with relatively weak metropolitan governance frameworks. Nevertheless, local stakeholders found a range of ways to act on road safety. In Lisbon, linking pedestrian safety and accessibility with the needs of the senior population helped reduce both vehicle speeds and various barriers to walkability. In Riga, a dedicated Traffic Co-ordination Advisory Council has integrated road safety actions into core traffic and mobility management functions.

What we recommend

Develop mobility plans and observatories in cities

More local governments should adopt sustainable urban mobility plans (SUMPs) at the metropolitan level. Road safety action plans should be integrated or linked to SUMPs, since road safety is critical to making active travel both popular and inclusive. Governments should establish a framework for the collection and reporting of relevant urban mobility and casualty figures. Such urban mobility and road safety observatories should also be integrated into the development and review of SUMPs. This would make it easier to analyse and interpret road safety trends. Data on user behaviours and attitudes as well as on enforcement of traffic rules could be included.

Use appropriate indicators to measure the safety of vulnerable road users

The absolute number of road traffic fatalities and injuries are important indicators for monitoring road safety trends and setting road safety targets. However, to measure, monitor and benchmark the level of risks experienced by a specific road user group, the volume of travel by that group should be controlled for. To make this possible, the number and length of trips in each mode should be systematically collected and monitored. A range of solutions are available for this purpose, including household travel surveys. To secure funding for data collection, cities should consider working in partnership with metropolitan authorities, national authorities, and authorities in charge of public health or using simplified but standardised survey methods.

Collect traffic casualty data from hospitals and from the population, not only from police records

Developing reliable data on injuries is especially important at city-level where low absolute fatality numbers can hamper statistically significant insights. All stakeholders should seek to establish protocols for the collection of injury data from the health and emergency services. Their goal should be to complement police records, which are often the only source of information on casualty numbers in spite of the notorious underreporting of casualties in police records. The categorisation of injury severity using an international medical standard called MAIS3+ is recommended to enable the monitoring of progress over time and to make meaningful comparisons across cities. Population surveys could help estimate and monitor the self-reported number of people injured in traffic, although they should not be regarded as a substitute for hospital data.

Improve the comparability of road safety statistics

The comparability and relevance of benchmarking indicators should be consistently questioned. To improve the comparability and relevance of mortality rates, especially in central urban zones where the resident population does not always reflect the true daytime activity, all cities should estimate a daytime population figure.

Adopt ambitious targets for casualty number reduction

Cities should adopt ambitious targets for reducing road fatalities and serious injuries, in line with the Safe System principles. Large performance gaps with regard to road safety exist between cities, and could help secure political support for ambitious casualty reductions.

Focus on protecting vulnerable road users

Cities should intensify their efforts in improving the safety of vulnerable road users. These make up the vast majority of urban traffic fatalities and are exposed to a significantly greater level of risk. Cities should enhance provisions for people to walk and cycle more safely and more often. A particular focus should be placed on street (re-)design and on protected infrastructure, such as segregated cycling paths. Such measures can also reduce the speed and volume of motor vehicle traffic, thus reducing the risk of road casualties, and will generally have positive impacts on public health and inclusiveness.

Conduct further research on crash risks

Crash data from a larger set of cities is needed to address open questions through more research. The relationships between urban shape, density, speeds, modal share and road user risk in particular requires further investigation. Gender questions and social aspects of road safety should also be examined in more detail. This will require robust casualty data as well as reliable data on trips. An immediate focus should be placed on the analysis of casualty matrices to reveal number of people in each user group which are killed or seriously injured in crashes involving another user group.

Local government should demonstrate leadership

Strong political leadership from local government is needed for successful road safety policies at city-level. It should both incentivise and co-ordinate the actions of stakeholders, including ministries, local authorities, road agencies, parliamentarians, politicians and civil society. A coherent narrative which brings together transport and land-use policies needs to be developed in order to achieve the long-term goal of delivering a safe and sustainable urban environment.

Gather evidence that can serve as fundament of road safety policy

An evidence-based approach to road safety helps secure broader support for action. It would also help direct road safety investments to where they are most effective. An evidence-based approach involves gathering data on crashes and traffic incidents, developing analytical methods to understand road safety problems, and building channels for stakeholders to be consulted and to contribute.

Create strong Metropolitan Transport Authorities

Metropolitan Transport Authorities (MTAs) are the key to enhancing integration between transport and land-use planning. An MTA that covers the entire commuting area can co-ordinate among jurisdictions at all territorial levels and reduce negative consequences of urban sprawl. MTAs can effectively contribute to national policy goals (e.g. on health, environment, inclusiveness), promote integrated land-use and transport planning, and thereby improve road safety.

Introduction

Over three-quarters of the population in the European Union lives in urban areas (UN, 2018) and over 9 000 people were killed on urban roads in 2017 (European Commission, 2018). Fatal crashes between road users remain a common occurrence on city streets, whilst they have almost been eliminated in rail or air transport. A growing number of local governments are embracing Vision Zero: a vision of no one being killed or seriously injured in urban traffic to rectify this. In support of such ambitious targets, this report investigates key road safety questions in the context of selected cities in Europe and beyond.

First and foremost, there is a basic need to understand which governance principles have the potential to facilitate a move towards safer urban environments. A lack of coherent governance frameworks impedes authorities in their quest to achieve better road safety outcomes. Cities often rely on solutions from regulators or vehicle manufacturers, neglecting a vast range of policies and actions they could develop locally. Land-use planning, sustainable mobility planning, traffic calming: these are examples of the tools available at the local level. Advancing good governance is vital to delivering effective road safety policies that would also bring wider societal benefits.

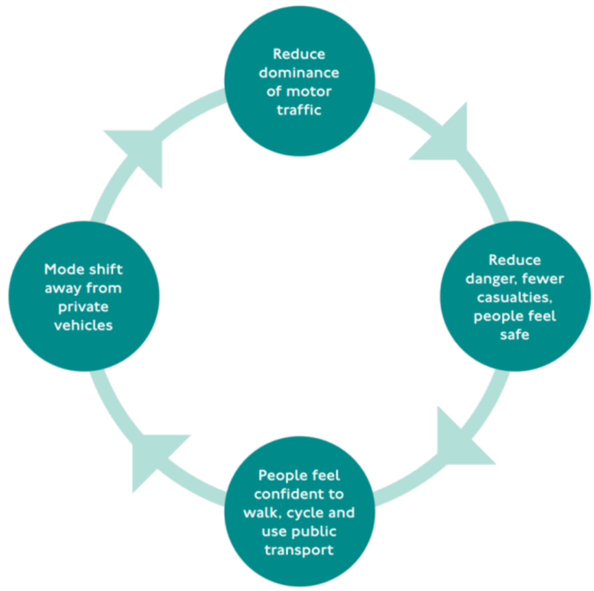
Increasing evidence suggests that the true impact of road safety in cities goes well beyond the direct suffering due to crashes. For instance, road safety determines the success or failure of the sustainable urban mobility transition, with a range of health benefits at stake, not to mention other social, economic and environmental benefits. Road safety objectives thus cannot be seen in isolation and should be embedded in the scope of wider developmental objectives. As this approach requires improving the functionality and co-ordination of a wide range of actors, the task is of a different order than more traditional, technical interventions. Addressing the preventable issue of inadequate road safety requires dedicated action by multiple ministries, most notably those concerned with law, planning, transport, education, public information and health.

How can cities achieve better road safety outcomes? How can authorities better link road safety to wider development objectives? What type of governance framework is needed for coherent, co-ordinated action by the various national and local agencies and organisations that have influence over road safety? Answering these questions is an important step in addressing a general lack of detailed evidence on the governance principles that would help promote road safety in cities. While analysis of city case studies has the potential to provide some useful material and insights, performance is not easily measurable and detailed examination is still needed to compare cities or assess the quality of governance regimes.

The effectiveness of road safety management needs to be systematically evaluated not only in terms of results, but also of the intervention package and institutional delivery. Transparent, accurate road traffic injury data are essential for setting priorities and developing policies that work. For instance, determining whether the same road safety challenges are found in cities and rural areas will help reveal which policy recommendations are most relevant. In line with the Safe System approach (ITF, 2016b), a thorough understanding of specific urban road safety issues is essential for cities to deliver on their Vision Zero ambitions.

Some would argue that cities face much greater public health problems. Local air pollution is one example. Chronic diseases, made worse by a lack of physical activity, is another. In response to these problems, local governments encourage people to walk and cycle more. There is a direct link between road safety and wider public health objectives: people will not embrace modal shift if they do not feel safe on the streets. Figure 1 shows how increasing road safety leads to broader public health benefits.

Figure 1. Virtuous circle of road danger reduction



Source: TfL (2018), Vision Zero Action Plan, http://content.tfl.gov.uk/vision-zero-action-plan.pdf.

Since road safety has an impact on modal choice, it is also useful to ask what the impact of modal choice on road safety is. Where walking and cycling are more dangerous than travelling by car or taxi, is there still a case for encouraging people to change mode? Faced with road network congestion, many city dwellers choose to travel by powered two-wheelers (PTWs). What is the road safety performance of this vehicle type? More generally, what can be learned about the relative safety of each mode, the impact of one transport mode on the safety of other road users, and the road safety solutions most relevant to each mode?

Current data collection methods have enabled the ignition of this research and give visibility to the following important areas. Which cities have the best road safety performance? What factors explain this performance, and are there lessons learned that can benefit other cities? Which indicators are most relevant in assessing safety performance and should therefore be adopted as targets? Are figures comparable between cities?

Seeking to answer this range of questions, the International Transport Forum (ITF) has analysed road safety in two dimensions: governance and performance indicators. Using these dimensions as a guide, this report has two main sections. The first part discusses casualty trends, compares casualty rates among cities and examines user groups involved in crashes. The second part presents case studies of road safety governance in two medium-sized European cities – Lisbon in Portugal, and Riga in Latvia. These identify the role of specific policies and governance arrangements in improving road safety performance.

The scope of the case study analyses is limited to recent years, since 2010. This part is essentially based on site visits and stakeholder interviews conducted in September 2017 in Lisbon and May 2018 in Riga. One objective of the analysis was to illustrate the strengths and weaknesses of the local governance framework in this policy area. Another was to highlight practical solutions in both cities. Overall, the second part of the report makes recommendations on governance frameworks and technical solutions.

Road safety performance indicators

Road safety performance indicators are designed to help diagnose problems, to identify best practice and to support policy monitoring and evaluation. The scope of this section is limited to data on casualties, mainly fatalities. A broader performance analysis could include reviewing cities' road safety strategies, action plans, budgets and governance arrangements. The monitoring of behaviour, perceptions and attitudes among city dwellers could also add value. It seems natural, however, to focus on casualties as the measurable outcome which matters the most to people.

This section also looks at the relevance of various indicators, available data collection methods and challenges associated with data comparability across cities. This material should be used to support a more vigorous approach to road safety management, with a goal of closing the gap and matching the best-performing cities. It should also be noted that no single indicator could capture all aspects of performance: a city may perform well on some aspects and poorly on others. The goal of the benchmark is not to point the finger at some cities; countless others have much worse road safety performance but no desire to join a benchmarking network such as the ITF Safer City Streets.

Accounting for various city shapes and definitions

To put the performance of 18 European cities in a global context, the ITF collected road safety data from 12 non-European cities: ten in the Americas and two in Oceania (Figure 2), totalling 31 cities involved in the benchmarking. The term Europe refers to the 28 EU countries plus Norway and Switzerland in this report.

The ITF did not commission an independent data audit in each participating city and could not fully assess the level of accuracy of each data contribution. The ITF does, however, use quality control procedures involving internal consistency checks, comparison with alternative sources, and comparison with known values in comparable regions. In addition, it collects relevant information on data sources and survey methods so as to elaborate correction factors where needed.[1]

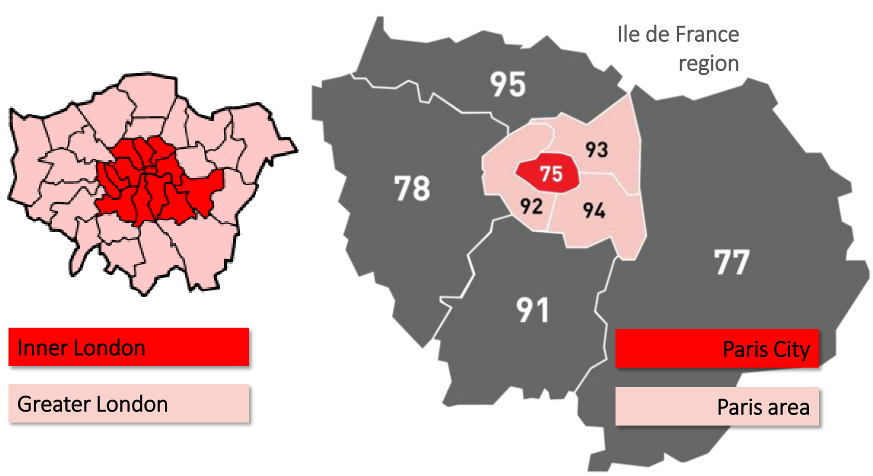
In spite of the heterogeneity of the data presented in this document, the publication of road safety and mobility figures at city level should be seen as a step forward. The circulation of this document is intended to maximise the level of scrutiny given to the data.

Figure 2. Cities contributing to the Safer City Streets database

Note: Bubble size indicates population size.

In the London and Paris metropolitan areas, data were collected at two geographical levels: the inner and greater urban areas, and were analysed separately (Figure 3). This approach is needed to understand how performance differs between urban cores and outer fringes.

Figure 3. Concentric urban perimeters in London and Paris
(to scale)



Notes: Greater London includes Inner London and Paris area includes Paris City. Numbers are French administrative division identifiers. London and Paris are drawn to the same scale.

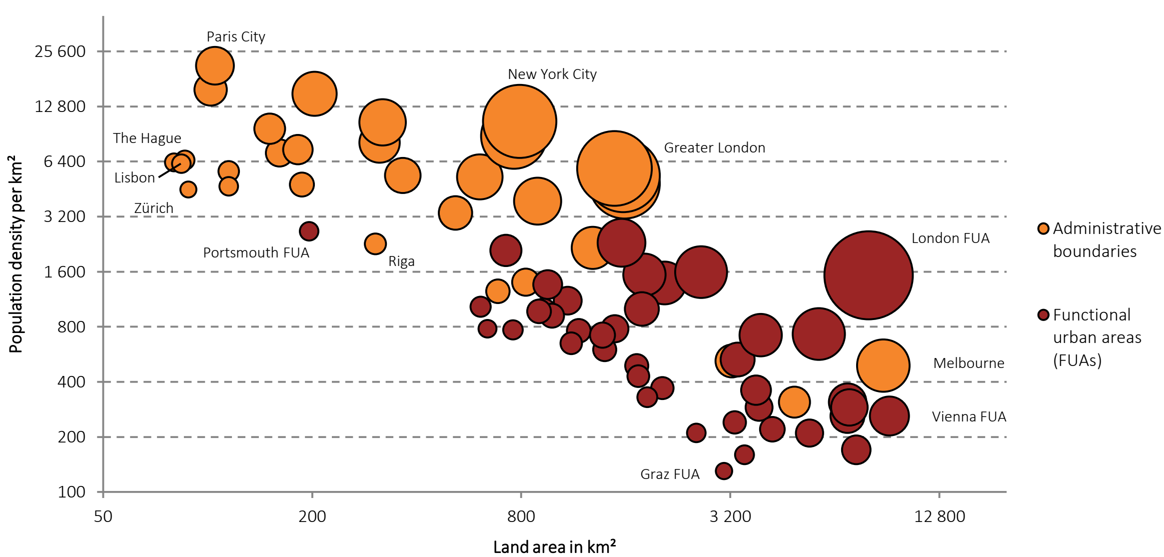
Source: Adapted from Morwen (Creative Commons).

In addition to collecting data directly from cities, the ITF collected data from national- and European-level databases and other sources. These data pertain to 41 functional urban areas (FUAs)[2] across Europe. Thus the ITF consolidated casualty data from various sources on 72 urban areas, 60 of which are in Europe.

Before examining road safety figures, the differences between the 72 areas examined must be considered. Figure 4 is a bubble chart representing the population of these areas, some of which being defined by administrative boundaries, others being defined as FUAs. The latter, of course, tend to occupy a larger land area (horizontal axis) and have lower population density (vertical axis). The plot reveals the diversity of situations:

- Land area varies from 80 km^2 (The Hague) to over 9 000 km^2 (Vienna FUA)
- Population varies from 400 000 (Zürich) to over 12 million (London FUA)
- Population density varies from 130 people per km^2 (Graz FUA) to over 21 000 per km^2 (Paris City).

Figure 4. Population density and land areas of selected cities



Indicators are normalised to facilitate comparison between areas of various sizes in this report. It could be argued that such comparison is unfair, as denser areas tend to be safer – an issue investigated in the section below. Preliminary results indicate that where population density doubles, road mortality goes down by 20%, a fact worth bearing in mind when comparing cities.

Why are some cities safer than others?

The indicator most frequently used to measure road safety is number of road fatalities per unit of population, also called road mortality. Often computed at national level, road mortality can be misleading when computed at city level, as activity levels in some cities cannot be measured by resident population alone. In urban cores, where many jobs and services are concentrated, the daytime population can be much higher than the resident population.

Daytime population is defined as resident population plus net flow of commuters towards a given area. This figure is important to better capture the activity level within an area and was provided by 19 cities. In FUAs, the assumption is that resident and daytime population are not significantly different, since the FUA definition is based on commuter flows.

For a fair comparison of mortality rates, only daytime population is used in this report. Results in Figure 5 reflect a wide range of situations, with annual fatalities per 100 000 population from 0.8 to 7.4 and a median of 2.3. Given this range, there is certainly room for performance to improve in most cities, at least by catching up with safer cities. The setting of ambitious road safety targets is therefore recommended, as targets have been shown to accelerate reduction in fatality numbers (Allsop et al., 2011).

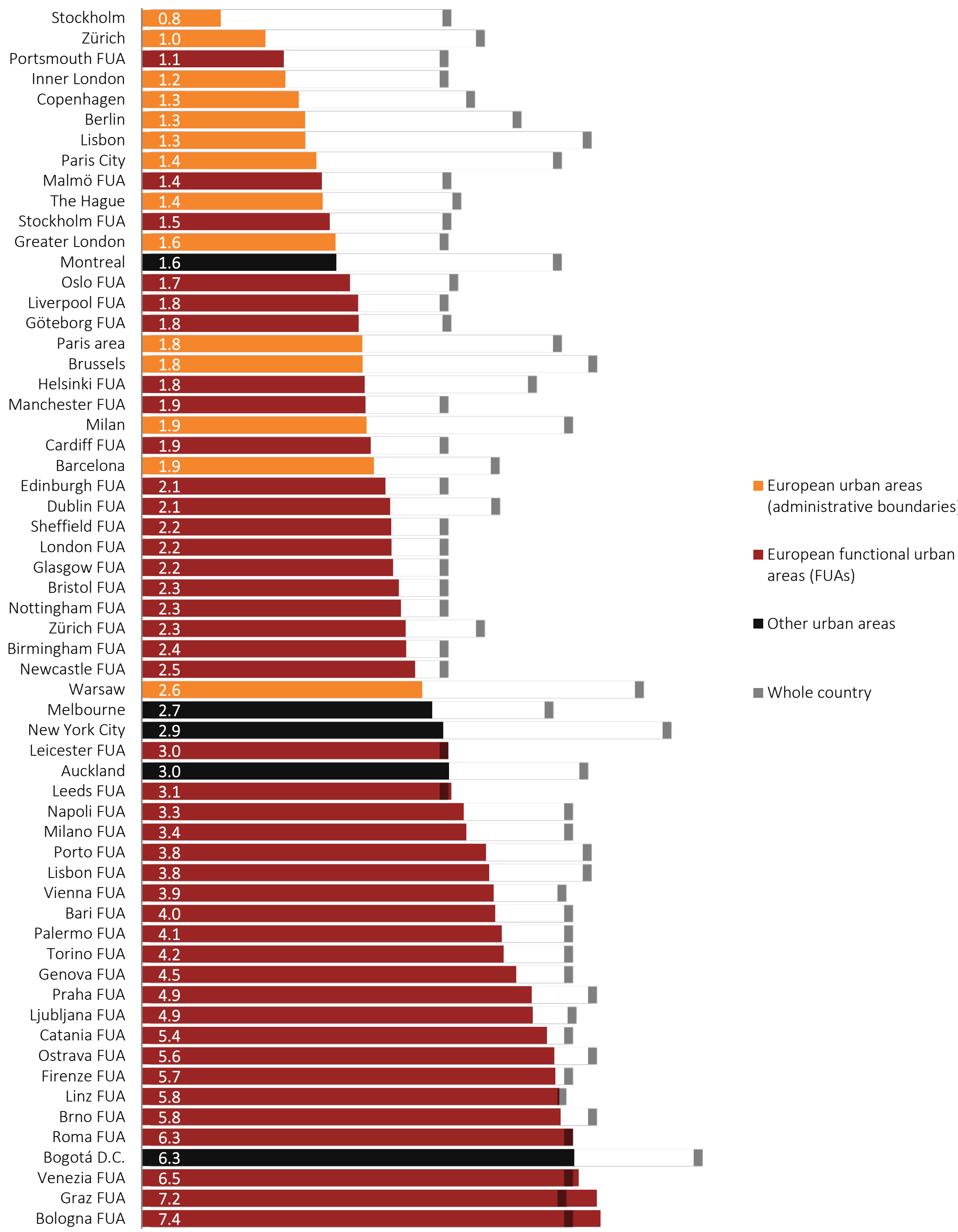
The analysis revealed that mortality rates rise with the size of the urban perimeter. That of Greater London is higher than that of Inner London, for example, and that of the whole London FUA is even higher. A similar pattern was observed in Paris and Stockholm.

The influence of city size and population density was investigated[3] and is represented in Figure 6. It reveals an elasticity[4] of mortality with regards to density. Where density is twice as high, mortality is 20% lower (elasticity of -0.32).

The variations observed in mortality could however be explained by other variables than density, such as public transport use which is often associated with population density. This question couldn’t be explored further because data on public transport use was not available in Eurostat.

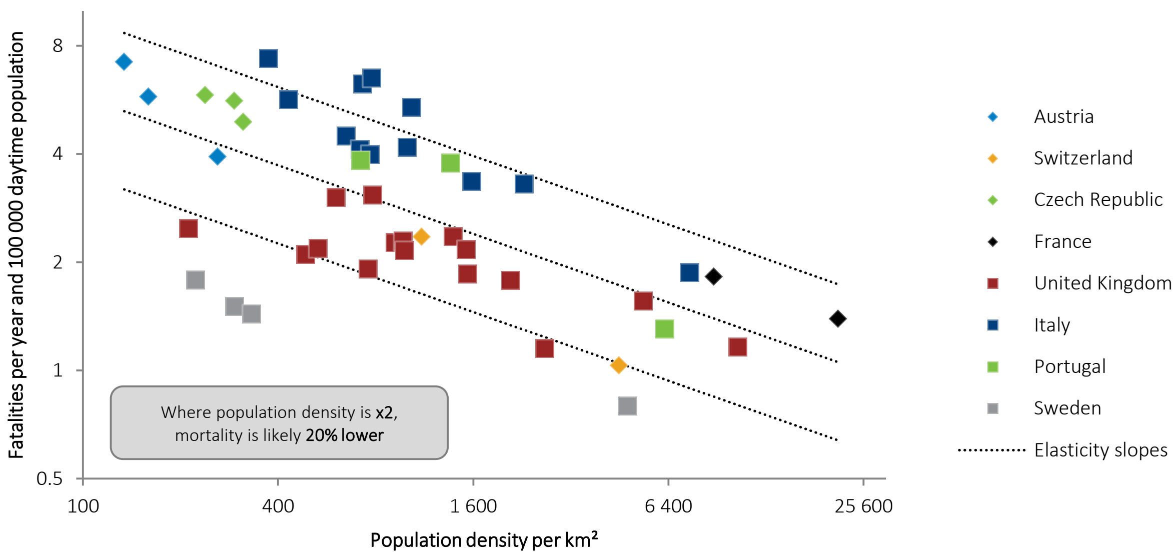
It is also true that population density may give an inaccurate picture of the true urban fabric. Vast tracts of empty land, for instance, could distort population density, even if the entire population lives in a dense urban core. To correct for this and better reflect the perception of an average resident, we rely on the concept of population-weighted density. An area’s population-weighted density is the mean of the densities of smaller areas (such as the cells of a grid system or census wards) weighted by those areas’ populations. It is best to compute the population-weighted density of urban area before undertaking further research on the intricate relationships between population density, mobility patterns and road safety.

Figure 5. Road fatalities in selected cities, 2011-15
(per 100 000 daytime population, average)



Notes: Argentina, Brazil and Colombia: 2013 data from ITF (2017). Latvia and Serbia: fatality data from OECD online database. *Other countries:* ITF IRTAD Database (2011-2015).

Figure 6. Elasticity of mortality with regard to population density in European urban areas
(2011-15 average)



Further research could investigate why denser cities tend to have lower mortality rates, and why cities in general tend to be safer than their country as a whole. Several hypotheses can be made to explain the phenomenon as denser cities tend to:

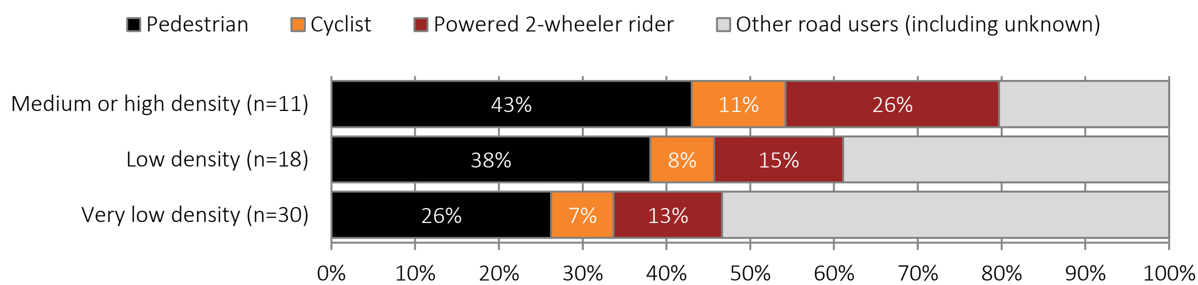
- have a higher proportion of trips using public transport, a famously safe mode of travel (Santacreu 2018b)
- have a higher proportion of trips by foot or bicycle, modes that, as this report will show, tend to be safer than other modes
- constrain motor vehicle speed
- allow access to a vast choice of jobs and services within a relatively short distance, which can reduce total distance travelled per person per day, and hence risk exposure.

Why are some modes safer than others?

Vulnerable road users (VRUs) typically represent 80% of road fatalities in the 11 urban areas with population density greater than 5 000 per km². Figure 7 summarises the proportions of various road user groups in total traffic fatalities, as observed in FUAs and urban administrative areas across Europe. Interpreting such figures, however, is difficult. The large proportion of VRUs in urban traffic may reflect a large modal share (a matter of exposure), a high level of risk, or both.

Figure 7. Modal shares of road fatalities in selected cities and functional urban areas, 2011-15

(by population density group)



Note: Very low density is less than 1 000 people per square kilometre, low is less than 5 000, medium is less than 10 000, high is 10 000 and above. Density bands are consistent with previous ITF work that did not include FUAs (Santacreu, 2018b). Where cities are grouped, figures represent the unweighted average across cities in the group.

This section examines the safety performance of various modes of transport in cities, leading to a discussion on the potential benefits of modal shift. The safety performance of each mode is defined as the probability of being killed in a collision for a given unit of distance travelled or for each trip made. This is the concept of risk and is computed as the number of fatalities among a given road user group, divided by the total distance or total number of trips travelled by this group over a given period.

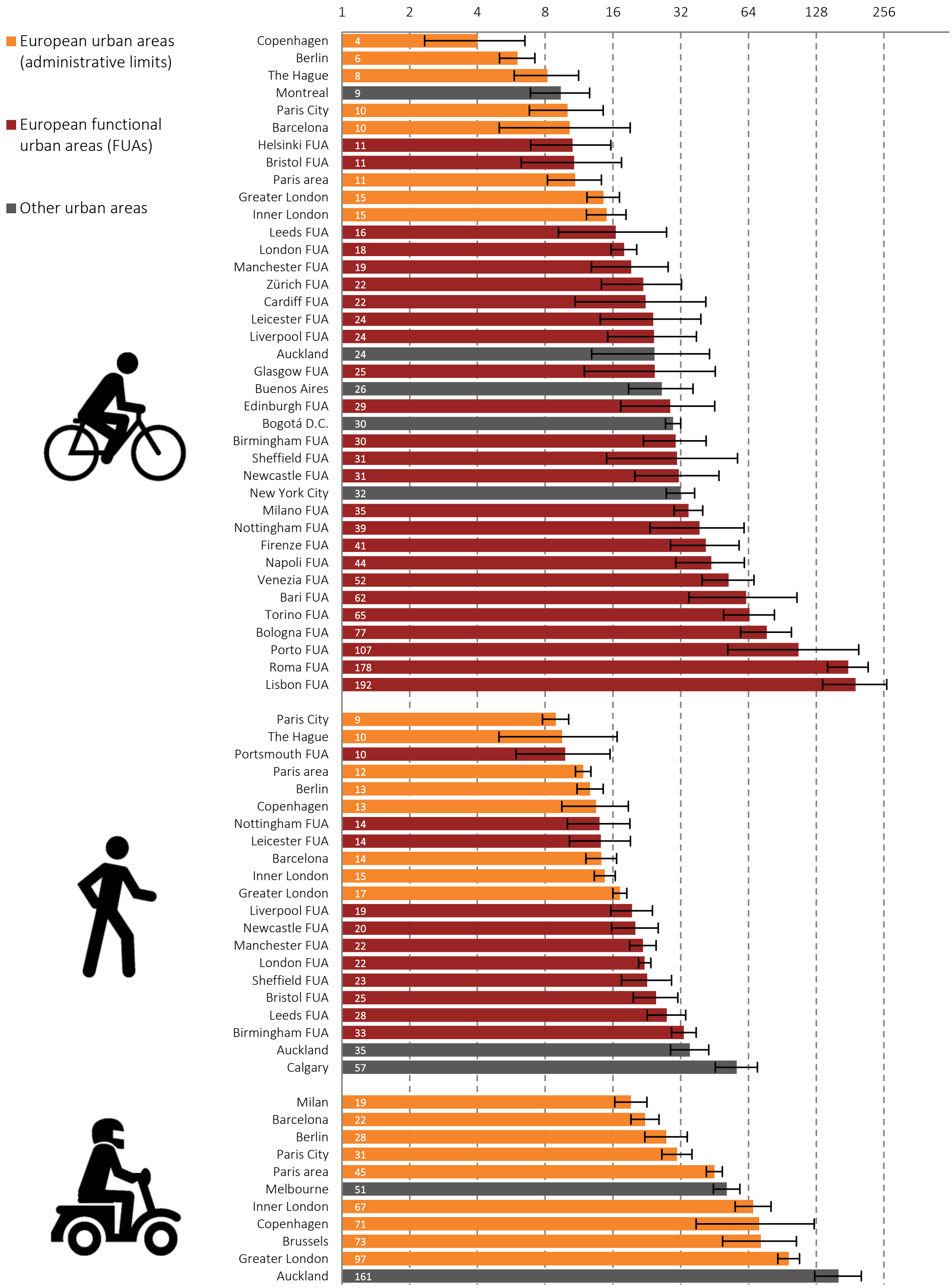
Risk of fatality per unit of distance travelled or trip made

This report proposes to measure risk by controlling for distance travelled or trips made. Some would argue that time is a more appropriate choice, especially when comparisons are made across modes. Others, constrained by a lack of data, use trips as the denominator. The ITF primarily uses distance, the most common metric, and trips when distance is not available. This is in accordance with a recommendation in the methodological framework of the Safer City Streets initiative (ITF, 2016a).

Large variations in risk can be observed across cities (Figure 8). The risk of being killed on a bicycle varies more than tenfold. The risk experienced by pedestrians varies sixfold. Again, this could be interpreted as room for progress, and could help cities to learn from their peers. Differences observed across cities reflect, to some extent, differences already observed across countries where the ITF reported cycling risk values that range between eight and 51 fatalities per billion kilometres cycled (Santacreu, 2018a).

Figure 8. Risk of fatality by mode and by city, 2011-15

(per billion passenger-kilometres)



Notes: Confidence intervals (80% level) are determined by the number of fatalities to reflect natural random fluctuation of small count data. No risk figure is presented where less than five fatalities are reported. For other caveats, see Annex A and B.

A particularly remarkable finding is that fatality risks for both walking and cycling are typically lower in a city when compared to the national average. This comment is based on a comprehensive set of national-level risk figures for walking and cycling compiled for the ITF Roundtable on Cycling Safety (Castro et al., 2018). The difference is most visible in Paris City, where the walking and cycling fatality risks are less than half the national averages. Similarly, in New York City, the cycling risk is significantly lower than the national average, which is estimated at 49 fatalities per billion km cycled (Santacreu 2018a). This may support the hypothesis in the previous section that dense urban fabrics result in lower motor vehicle speeds. More research dedicated to refining this analysis and controlling for a number of potentially confounding factors, such as age, gender and time of day, would be useful. National statistical authorities are also invited to review their travel surveys and make sure active travel data are at least as robust as motorised travel data. See Armoogum (2014) and COWI (2017) on travel survey harmonisation and improvement.

Results also highlight the fact that cycling is not as dangerous as people often suppose. In a majority of cities, it seems to be safer to travel 1 km on a bicycle than on foot. The main caveat here is the acknowledgement of confounding factors: in particular, if the two user groups (cyclists and pedestrians) have different age distributions and fitness levels, physical resilience may contribute to the difference observed here.

To compare fatality risk across transport modes, a comprehensive data set covering five modes in five cities: Auckland, Barcelona, Berlin, London and Paris, was assembled. Table 1 shows figures for each city and each mode, along with the median risk across all five cities. Riding a powered two-wheelers (PTW) rather than a pedal cycle over a given distance quadruples the risk of fatality. Walking a given distance carries ten times the risk of fatality as riding the same distance in a passenger car. Travelling by bus is an order of magnitude safer than all other modes of travel.

Table 1. Number of fatalities per billion passenger-kilometres, average 2011-15

City	Bus	Passenger car	Pedal cycle	Pedestrian	Powered two-wheeler
Auckland	0.4	1.9	24	35	161
Barcelona	0.0	0.7	10	14	22
Berlin	0.0	0.5	6	13	28
Greater London	0.2	1.4	15	17	97
Paris area	NA	1.4	11	12	45
Median	**0.1**	**1.4**	**11**	**14**	**45**

How should policy makers interpret such results? Certainly one conclusion is that developing public transport is a key to reducing road fatalities. Could there be a case for promoting private car use in cities, replacing some walkable or cyclable trips by car trips, on road safety grounds? This would overlook the risk imposed by motorised road users on other user groups, something which is not reflected in Table 1, but discussed later in this report.

Table 2. Number of road fatalities by mode in selected cities

(per unit of distance and trips travelled, 2011-15 average)

City/FUA	Fatalities per billion passenger-kilometres				Fatalities per billion passenger trips			
								
Auckland	1.9	24	35	161	18	120	32	1 100
Barcelona	0.7	10	14	22	6	21	16	132
Bari FUA		62				288		
Berlin	0.5	6	13	28	5	21	13	276
Birmingham FUA	1.3	30	33		16	167	44	
Bogotá D.C.		30			26	257	118	670
Bologna FUA		77				356		
Bristol FUA	0.7	11	25		10	50	36	
Brussels	2.2			73	27		64	400
Buenos Aires		26				79		
Calgary			57				57	1 164
Cardiff FUA		22				103		
Copenhagen		4	13	71				
Edinburgh FUA		29				133		
Florence FUA		41				191		
Glasgow FUA		25				113		
Helsinki FUA		11				49		
Leeds FUA	1.6	16	28		21	102	40	
Leicester FUA	1.7	24	14		25	110	18	
Lisbon FUA		192				885		
Liverpool FUA	1.1	24	19		13	113	30	
London (Inner)	1.0	15	15	67	6	70	24	587
London (Greater)	1.4	15	17	97	7	69	30	434
London FUA	1.3	18	22		17	100	36	
Manchester FUA	0.9	19	22		10	91	30	
Melbourne	1.3			51				
Milan	1.0			19	12			161
Milan FUA		35				160		
Montreal		9						
Naples FUA		44				202		
New York City		32				128		
Newcastle FUA	1.3	31	20		19	179	28	
Nottingham FUA	1.4	39	14		18	168	20	
Paris area	1.4	11	12	45	11	31	14	333
Paris City		10	9	31		30	12	205
Porto FUA		107				492		
Portsmouth FUA	0.5		10		7		15	
Rome FUA		178				820		
Sheffield FUA	1.0	31	23		13	189	32	
The Hague	0.5	8	10		5	31	10	
Turin FUA		65				299		
Vancouver							64	
Venice FUA		52				241		
Zürich FUA		22				101		

Notes: There is considerable uncertainty on some values due to low numbers of reported fatalities. For this reason, no risk figure is presented where fewer than five fatalities are reported. With heterogeneous methods used for the estimation of trips and distances travelled (Annex A and B), extra care should be taken regarding interpretation of differences across cities.

Fatality risk imposed upon third-parties

Occupants of private cars are remarkably well protected from the risk of being killed in traffic, especially in urban areas. On the other hand, they contribute to a significant risk of VRUs, such as pedestrians, being killed in collisions with cars (Scholes et al., 2018). Table 1 does not account for that phenomenon and more research in this area is needed.

At the third Safer City Streets meeting, the city of Bogotá reported on its efforts to consolidate information on road casualties across three different sources: the police, the National Institute for Legal Medicine and the public health secretary. Consolidated 2017 figures in Bogotá suggest that that while 19 private car occupants were killed in traffic crashes, 133 (seven times more) VRUs were killed in crashes involving a private car. On the other hand, in a year when 59 cyclists were killed, only three pedestrians were killed in collisions with pedal cycles. This illustrates the significant impact of one road user group on others, relatively modest in the case of pedal cycles, yet overwhelming in the case of private cars.

Bogotá pays particular attention to monitoring and improving the safety record of the taxi trade. Taxis are clearly separated in the collision statistics, which is something other governments could learn from. The matrix below gives a complete picture of the number of fatalities resulting from each crash configuration in Bogotá in 2017.

Figure 9. Traffic fatalities in Bogotá per mode and per vehicle involved, 2017

	Pedestrians	Pedal cycles	Motorcycles	Private cars	Buses	Taxis	Goods vehicles	Other vehicles	No third party	More than two parties (+2)
	0	3	74	86	49	21	23	0	0	16
	1	0	2	11	16	3	10	0	12	4
	4	1	6	32	19	7	31	0	35	17
	1	0	0	4	8	3	5	0	4	5
Bus driver	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	1	0	5	0
Taxi driver	0	0	0	3	1	0	0	0	0	0
Taxi passenger	0	0	0	0	1	0	0	0	0	1
	0	0	0	2	4	0	2	0	11	0
	0	0	0	0	0	0	0	0	1	0

Note: Each row is a road user casualty group and each column is a third-party vehicle involved in a collision.

Source: Presentation by Juan Pablo Bocarejo and Claudia Diaz at the third meeting of Safer City Streets meeting, Rome, April, 2018.

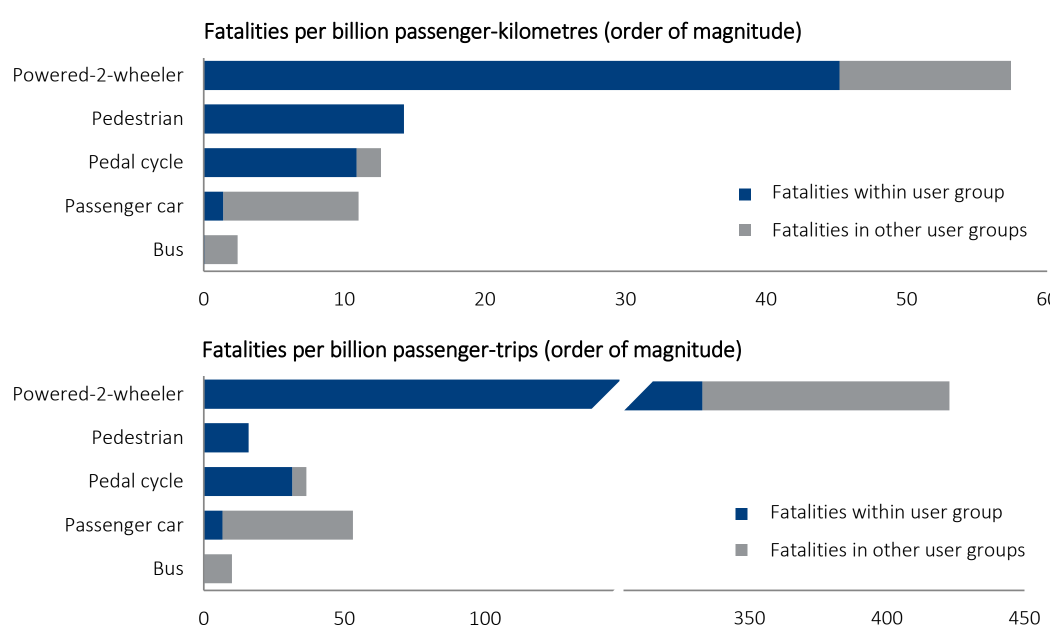
The goal of such cross comparison is not to attribute responsibility or to blame a particular user group, but to give an indication of the road safety benefits of modal shift. Calculations of third-party risk however reveal a high impact of motor vehicles on the overall casualty number, and therefore strengthen the case for a modal shift towards walking and cycling.

Controlling for distances in this situation, however, is questionable because modal shift often coincides with a shift in travel distance: people change destination, or even home, due to limited travel time budgets. Computing fatality rates per unit of *travel time* or per unit *trip* would arguably better assess the impact of modal shift. To illustrate how distance and time lead to different risk estimations, let us assume that urban trips on PTWs are twice as fast as cycling. The fatality risk of riding a PTW, previously described as four times as high as cycling for a set *distance*, would be found to be eight times as high as cycling for a set *duration*. When collecting further data from cities, the ITF will propose collecting travel durations in addition to distances.

Using data from Bogotá (Figure 9), Paris City and Inner London, a first estimate can be made of the number of third-party fatalities, so that the complete road safety impact of each transport mode is assessed. For a given user group, it is now possible to compute the *total* number of fatalities in crashes involving this given user group. In Bogota, Paris City and Inner London, the total number of vulnerable road users killed in collisions with cars is four to seven times higher than the number of car occupants killed in traffic. This indicates that car occupants, in dense urban areas, represent a greater risk to other road users rather than to themselves as a group.

To compare modes and assess the benefits of modal shift, the total number of fatalities involving each mode is divided by the number of kilometres or hours travelled with each mode. Figure 10 displays the total fatality risk as the sum of the risk to oneself and the risk imposed on others. In these two components of risk, the latter has yet to be investigated in a greater number of cities. For this reason, results should be seen as indicative, representing only an order of magnitude.

Figure 10. Number of fatalities in collisions involving a given user group in selected cities, 2011-15
(per unit passenger travel in this user group)



Sources: ITF. Fatalities, trips and travel distances from Auckland, Barcelona, Berlin, Greater London, Paris Area. Crash matrices from Bogota, Inner London, Paris City.

Figure 10 suggests that riding a powered two-wheeler (PTW) is associated with over four times more fatalities than riding a bicycle, in urban areas, controlling for kilometres travelled in each mode. Per trip travelled, riding a PTW is associated with over 11 times more fatalities than riding a bicycle.

Walking imposes virtually no fatality risk on other road users. However, people experience a higher risk when they walk in comparison to when they travel by bus or by car. Trips by car and PTW impose a greater overall fatality risk than a trip which is walked, cycled or travelled by bus. This analysis of fatality risk suggests that a modal shift away from private motor vehicles could deliver significant road safety benefits in dense urban areas, not to mention wider public health benefits linked with physical activity and air quality.

The effect of modal shift on road fatalities

A rapid interpretation of Figure 10 would support policies developing the use of cars and public transport in cities as a means of reducing fatalities, since the risk of being killed in a city when travelling inside vehicle bodywork is at least ten times lower than the risk of being killed when travelling the same distance on foot. However, the grey area in Figure 10 suggests that no obvious fatality reduction is to be expected in cities from a modal shift away from walking and towards using passenger cars.

In cities where a shift towards cycling is observed, some fear consequences in terms of road traffic fatalities. As discussed in a recent ITF Roundtable on Cycling Safety (Santacreu, 2018a), countries where people cycle the most have the highest number of pedal cycle fatalities per unit of population. Selected city- and FUA-level data confirm this (Figure 11). This does not however mean that cycling is more dangerous in places where people cycle more, as neither trip numbers nor time or distance are controlled for. One could also challenge the value of looking at pedal cycle fatalities in isolation. Indeed, trips which are cycled could have otherwise been travelled on PTWs, with higher risk. Similarly, driving can be more dangerous than cycling for some demographics (Feleke et al., 2018).

In fact, the cities where people cycle the most tend to have lower mortality rates (Figure 12) when casualties from all road user groups are added together. Longitudinal or even experimental studies would be key to strengthen this observation, which is based on cross-sectional data alone. Nevertheless, this finding suggests that an overall decrease in fatalities is possible in cities planning for a modal shift towards cycling. The Vision Zero policy would accelerate such a decrease.

Figure 11. Number of pedal cycle fatalities per unit of population, 2011-15
(in selected cities and functional urban areas)

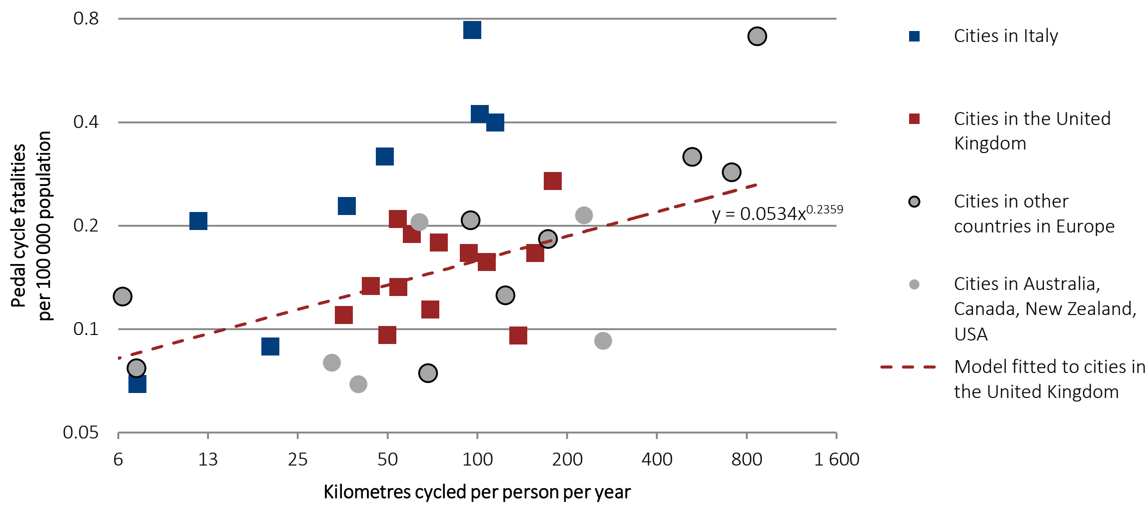
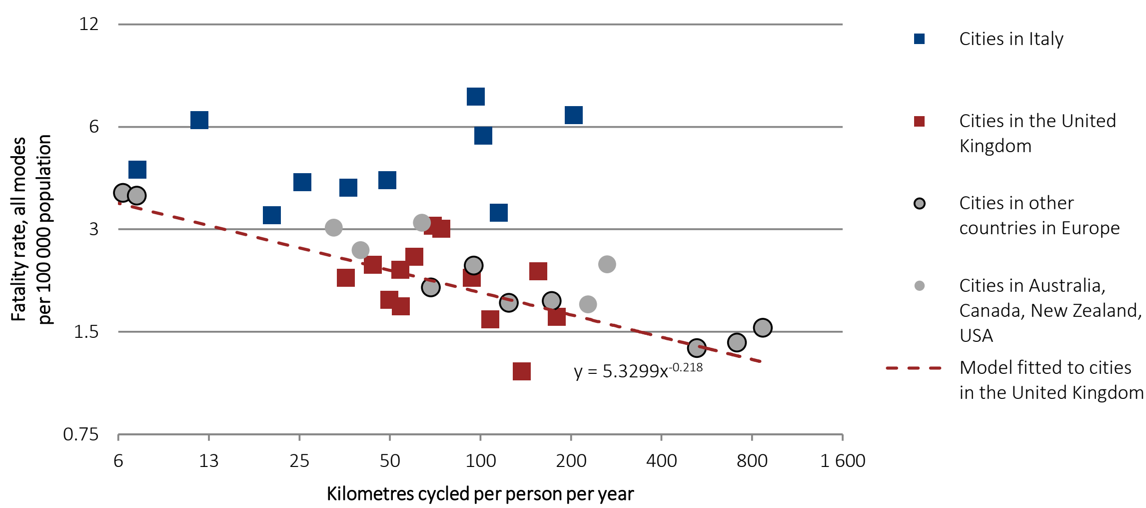


Figure 12. Number of fatalities per unit of population, 2011-15
(in cities and functional urban areas)



Notes: A regression curve was not fitted to the whole data set because of the likely influence of national-level confounding factors. A curve was, however, fitted to the data for the United Kingdom, for information only, as it is the country with the most data points.

This section reveals how misleading some indicators can be. A naive interpretation of Figure 11 would conclude that where people cycle more, more people die in traffic. The truth is that Figure 11 represents an indicator which is unbalanced by design and cannot be used to assess road safety performance: it is the ratio of the number of bicycle fatalities over total population, whether they cycle or not.

Instead, when monitoring and comparing cycling safety, an analysis of risk indicators is recommended where the amount of cycling is truly controlled for. The amount of cycling could be captured as distance, number of trips or cumulated duration. The same logic applies to other modes of travel. Risk indicators could be used in setting targets, in the hope of accelerating the reduction of casualty risk (Allsop et al., 2011).

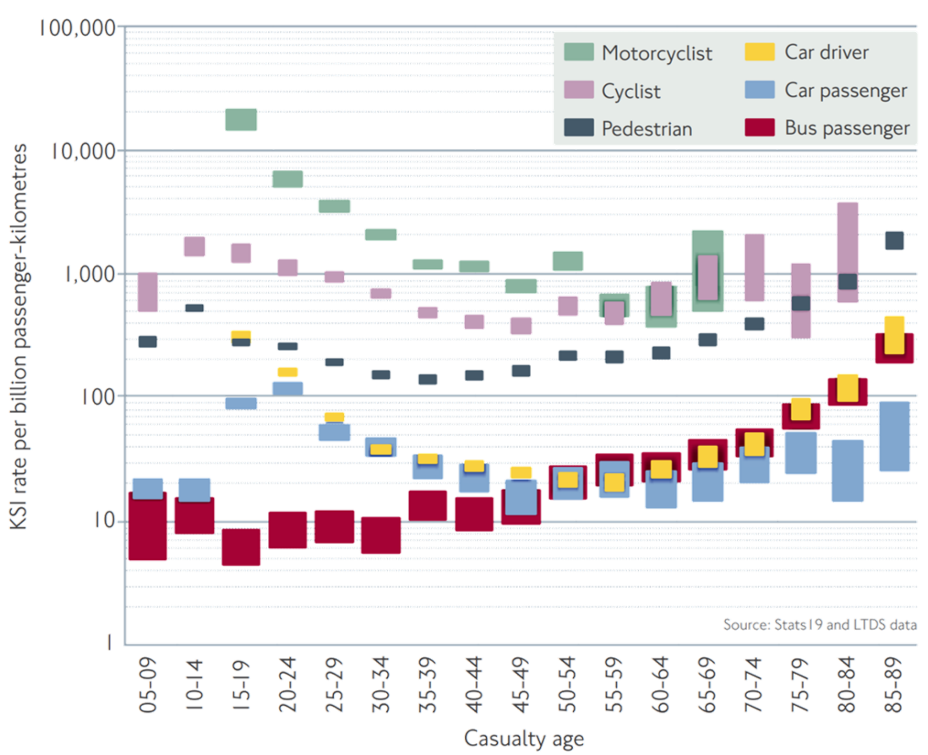
Casualty risk by age and mode

Differences in risk observed across modes should be interpreted with care, since the user demographics may be different. Among other factors, it is recommended to control for age, which has a significant impact on mortality and risk (Feleke et al., 2018). Revealing and monitoring casualty risk in different user groups is of great value to cities but requires significant data collection efforts, in particular to control for amount of travel.

One way to address such confounding factors has been developed by Transport for London (TfL, 2013), which cross-tabulates risk figures by user group *and* age group (Figure 13). By controlling for age and distance travelled, this method indicates that cycling carries a higher risk of death and serious injury than walking in London. In other words, the risk of being killed or seriously injured (KSI) per unit of distance travelled varies very significantly not only by mode but also by age.

Risk falls by a factor of ten for motorcyclists between the ages 20-24 and 55-59. Similarly, between the same age bands, the risk experienced by car drivers falls with age by a factor of ten. This phenomenon is most likely due to behaviour and experience. It is also noticeable among people walking and cycling, to a lower extent. In old age, however, risk goes up again, following a U-shaped pattern. For pedestrians, car drivers and bus occupants, the risk is multiplied by ten between ages 45-49 and 85-89. (Figure 13).

Figure 13. Casualty rate per billion kilometres by age and by mode in London



Note: Bar height represents confidence interval, which is higher where the sample size is smaller.

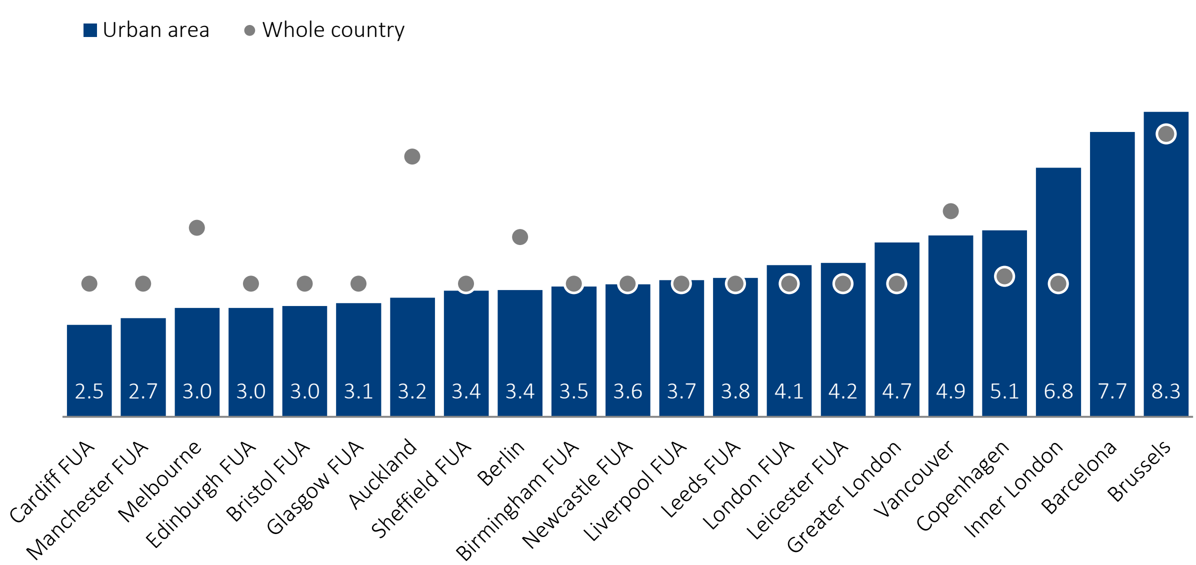
Source: TfL (2013).

Links between fatalities and traffic volume

This section examines a frequently used indicator, which complements the analysis and provides further insights. The indicator considers the *total* number of road traffic fatalities across all modes. To make it comparable across cities, it is normalised by volume of motor vehicle traffic, which covers all types of road motor vehicles subject to registration. That excludes pedal cycles but includes mopeds, motorcycles, cars, goods vehicles and buses.

Controlling for the volume of motor vehicle traffic, the number of fatalities ranges from 2.5 to 10 per billion vehicle-kilometres (Figure 14). This indicator reveals higher fatality rates in the areas which are the most densely populated. For instance, the rate is significantly higher in Inner London (6.8) than in the London FUA (4.1). One could speculate this is due to the high number of VRUs and the high likelihood of conflict between VRUs and motor vehicles. Indeed, almost all of the difference in rate between Inner London and the London FUA is driven by the number of pedestrian fatalities per billion vehicle-kilometres: 3.7 in Inner London against 1.4 in the London FUA (Figure 15).

Figure 14. Traffic fatalities in selected urban areas compared to country, 2011-15
(per billon vehicle-kilometres)

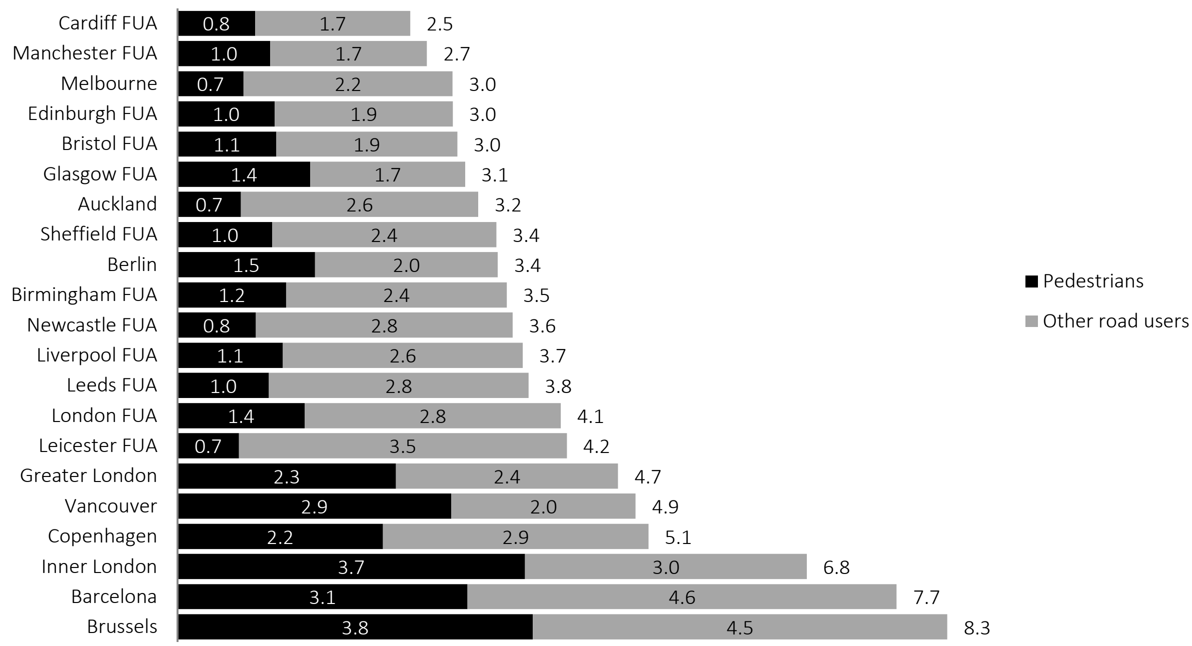


Note: Traffic volume data in Spain was not available.

Source: Country-level figures from ITF IRTAD database (2011-15).

If what was observed in London were generalised, fatality rates in cities would tend to be higher than country-level averages. Paradoxically many cities have shown to have lower fatality rates in comparison with their national average. Further analysis in this area would require more countries to estimate their traffic volume figures, especially Spain and Italy. It would also require collection of statistics on crash matrices showing the number of road users of a particular user group killed in crashes involving another particular user group (Annex B). It should be noted that not all fatalities involve a motor vehicle. For example, a significant proportion of bicycle crashes do not. The indicator, however, does not separate this out. Future research would therefore benefit from systematic collection of crash participant data, underlining the call for crash matrices made earlier.

Figure 15. Pedestrian traffic fatalities in selected urban areas compared other road user types, 2011-15
(per billon vehicle-kilometres)



Box 1. Estimating motor vehicle traffic in the United Kingdom

The UK Department for Transport (DfT) runs the National Road Traffic Survey, a continuous campaign of traffic counts across the country, so as to produce aggregate traffic figures by vehicle type, road type, region, year, etc. Among its data series, TRA8904 provides total motor vehicle traffic volumes by year and by local authority. Data were averaged over 2010-2015.

The ITF worked to aggregate these figures at FUA level. The DfT produced a lookup for LHAs (Local Highway Authorities) to FUAs. Some LHAs might only partially overlap with the FUA, in which case a fraction of their traffic volume is accounted for in the FUA total. This fraction is assumed to be proportional to the spatial overlap, an assumption which of course induces great uncertainty in the results. In two of the FUAs in the United Kingdom, traffic volume data could not be computed because boundary mismatch caused an uncertainty on the traffic volumes which was greater than +/-30%.

Women are less likely to die in traffic

Men are at least twice as likely as women to be killed in traffic. This is observed in the vast majority of cities (61 out of 68) where data is provided by gender. Figure 16 shows the ratio of men and women fatality rates per unit of population for each city. A ratio of 1 indicates equal risk for men and women. The ratio varies significantly by city, from values close to 1 to values greater than 4, as seen in Rome and, most remarkably, several Italian FUAs. While high ratio values are likely to reflect behavioural differences by gender, in particular different approaches to risk taking, it must be noted that high values can also be due to increased exposure in places where men make more trips and/or travel longer distances.

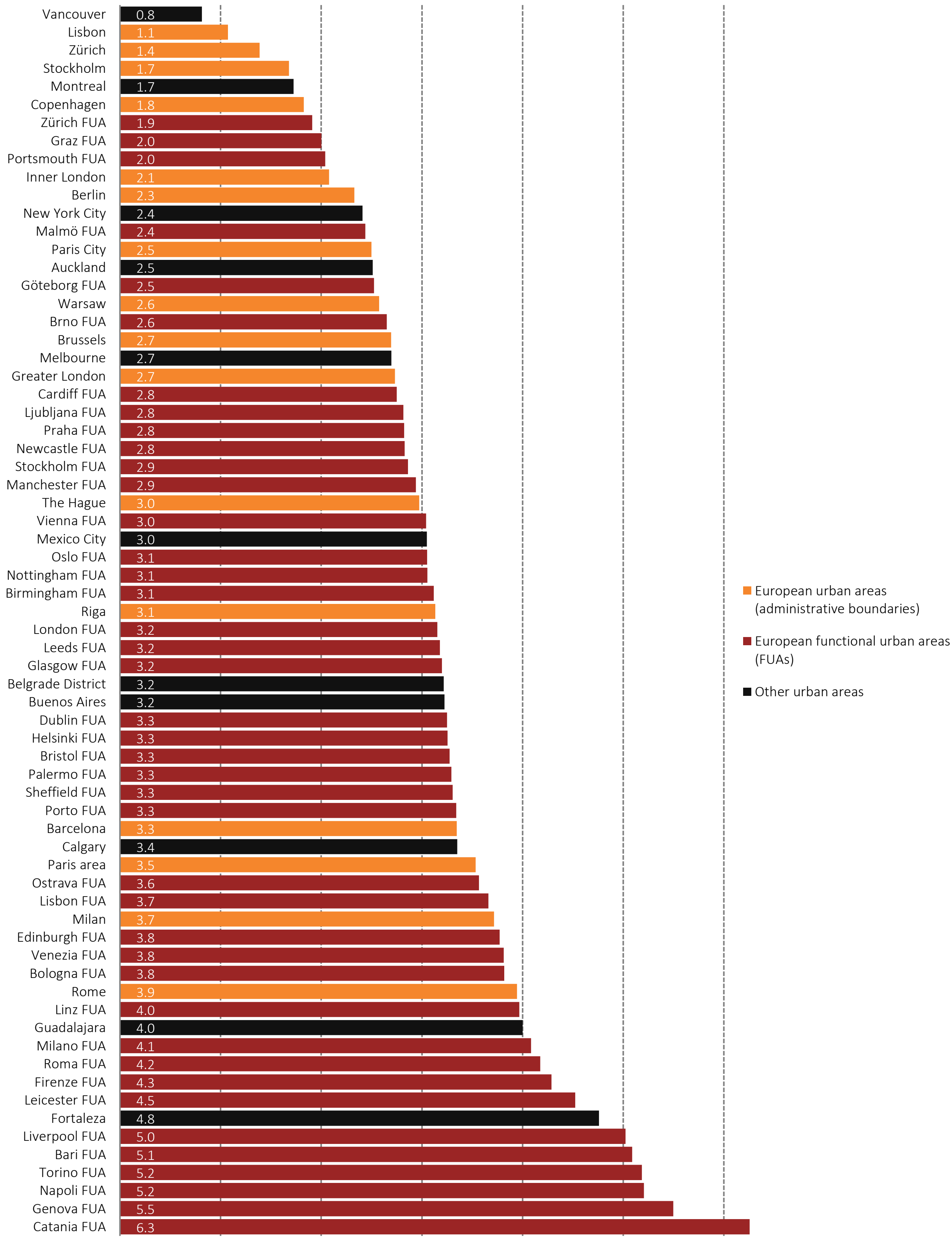
The data reveal that gender differences are attenuated in some urban cores, in comparison with wider urban areas. This is observed in both Paris and London, where the greater urban areas show higher ratio values. Interpretation remains difficult, however, due to the need to separate behavioural aspects from mobility (i.e. exposure) aspects.

Nevertheless, some research does exist where road user casualty risk is analysed by gender while controlling for amount of travel and transport mode. TfL (2014) merged its casualty data set with its household travel survey and found that male pedestrians, cyclists and PTW riders had a significantly higher likelihood of being killed or seriously injured than female road users, controlling for the distance travelled in each mode. In England, Feleke et al. (2018) used the National Travel Survey to reveal that fatality rates for walking, cycling and driving were higher for males than females at almost every age, and varied more by age than by travel mode.

Cities are encouraged to conduct travel surveys to measure differences in travel activity and mode choice between men and women so this can be controlled for when conducting road safety research. Women are less likely to be killed in traffic partly because they tend to travel shorter distances and prefer public transport to cars, according to the analysis of travel surveys in Auckland, Dublin, Hanoi, Helsinki, Jakarta, Kuala Lumpur, Lisbon and Manila (ITF 2018c).

Despite differences in travel activity, gender-specific behaviours and attitudes certainly contributes to the excess mortality observed among men. Reducing the mortality gap between men and women through better understanding and prevention of crashes involving males could be one step to rapidly reducing road mortality. Where male driver behaviour is found to be an issue, addressing it would not only save lives but also make the streets more liveable and inviting for other road users.

Figure 16. Ratio between male and female traffic fatalities, 2011-15
(per unit of population)



Serious injury monitoring remains a major challenge

Unlike fatalities, which are standardised to the 30-day convention and assumed to be relatively well reported in police statistics, serious injuries are an evasive concern. Different definitions are used across the world, reporting rates are low and they vary by country.

To reveal the scale of the problem, the ratio of serious injuries to fatalities is calculated. It varies from two to forty-three, a range clearly pointing to inconsistent definitions (Figure 17). The median is about 18 serious injuries per fatality.

In many countries, a "serious injury" in a road crash is defined by the police as an injury requiring at least 24 hours' hospitalisation, and recorded as such in their reports. This definition, however, covers a wide range of cases, from minor injuries requiring a period of hospital observation to serious injuries leaving the victims incapacitated for the rest of their lives.

Figure 17. Ratio of serious traffic-related injuries to fatalities in selected cities, 2011-15

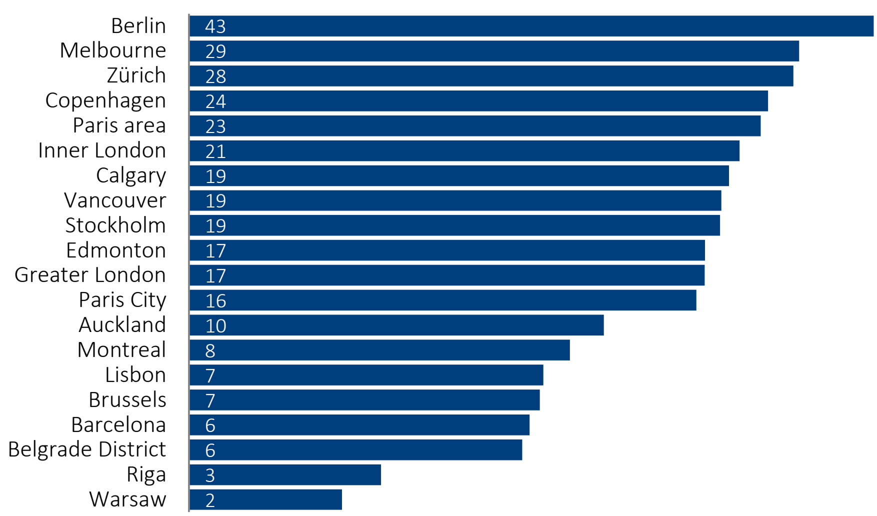


Figure 18. Ratio of MAIS3+ injuries to fatalities in selected cities, 2011-15

Hospitals in many countries apply medical definitions of injury based on the number and severity of injuries sustained. The definitions are contained in the widely used Injury Severity Scale, Abbreviated Injury Scale and Maximum Abbreviated Injury Scale (MAIS). They reflect the threat to life associated with the injury, rather than a comprehensive assessment of severity. Following a recommendation by the ITF (2011), a level of injury of MAIS3+ became the accepted cut-off for a serious injury, with anything below falling into the category of minor injury. A recent European Commission document adopted this definition and stated that in Europe in 2014 there were 135 000 serious injuries, by the MAIS3+ definition (European Commission, 2016).

The MAIS3+ definition can thus facilitate consistent monitoring of progress across time and meaningful comparison of figures across cities. Yet across the three cities where MAIS3+ injuries were monitored, the ratio of MAIS3+ injuries to fatalities ranges from four to sixteen (Figure 18). Such a wide range is unexpected, necessitating further investigation: Are cities using consistent methods for the estimation of MAIS3+ injuries?

Due to inconsistent definitions and poor reporting rates, combined with an absence of hospital data, injury data are not yet comparable across cities. That is why city-level road safety performance analysis is limited to fatalities. This choice affects the quality of the analysis in two ways:

- Much could be learned from injuries, as they do not necessarily follow the same pattern as fatalities.
- With a data set limited to fatalities, much statistical significance is lost in the variability of small numbers.

The second point has serious consequences for the analysis of data from a single city: with the inevitable variability of small numbers, monitoring of single-city and single-year fatality numbers is rarely insightful. A change in fatality number from one year to the next rarely leads to a statistically significant conclusion on whether the trend is up or down. This explains our key recommendation for cities to further engage in collection of robust, comparable injury data. Several methods exist; many are documented in ITF (2011), FERSI (2016) and SafetyCube (2016). Box 2 explains one approach.

Box 2. The Rhône Road Trauma Registry

The Rhône Road Trauma Registry is a population-based registry which collects data on all new cases of injuries occurring in the French Département du Rhône following a road crash, whether the victim is hospitalised or not. The Rhône administrative area has about 1.6 million inhabitants and significantly overlaps with the Lyon metropolitan boundaries. Injuries are coded on the Abbreviated Injury Scale (AIS). The register began in 1996 and involves 50 hospitals. It links with police records when available and uses common information (no common ID). A statistical model is trained on the Rhône data to estimate national injury figures from national police data. Under-reporting in police data is mostly influenced by severity, third-party involvement and type of police force.

Thanks to the local household travel survey, serious injury rates could be computed by unit of distance, by unit of time in traffic and by trip. The rate by unit of time is seen as the most relevant when making comparisons across modes. It leads to rankings that are relatively similar to rankings of risk by trip.

The register is a valuable resource for analysis of crashes that are often under-reported such as single-party crashes, walking and cycling injuries.

In the Rhône area, 95% of people with MAIS3+ injuries are hospitalised, which makes it possible to use hospital data alone to estimate a simple total. Yet if the goal is to examine both crash circumstances and trauma outcomes, the linkage with police data is essential.

Table 3. Risk of serious injury per unit of distance travelled and per unit of time spent in traffic, 2005-06
(by mode, Rhône Department)

Type of user	Incidence MAIS3+ per million km travelled	Incidence ratio
Car occupants	0.02	1
Pedestrians	0.17	8.5
Cyclists	0.73	36.5
Motorised two-wheelers	1.36	68
Type of user	**Incidence MAIS3+ per million hours travelled**	**Incidence ratio**
Car occupants	0.41	1
Pedestrians	0.65	1.6
Cyclists	6.42	15.7
Motorised two-wheelers	49.58	121

Source: Blaizot et al. (2013).

Conclusions from the analysis of road safety indicators

No analysis of road safety performance in cities would be complete without a review of road safety strategies, action plans, budgets and governance arrangements. Nevertheless, much can be learned from analysis of casualties, as the ultimate outcome of road traffic crashes.

Findings from this analysis supported earlier work done by the European Commission showing that mortality is lower in cities than outside of them. In fact, population density appears to be correlated with safety. A cross-sectional analysis reveals that mortality is 20% lower where density doubles. This is likely due to lower vehicle speed and greater use of public transport, but further investigation is needed. The Safer City Streets database and network could support such research.

This finding raises a difficult question: If streets in cities are safer than rural roads, why should urban road safety be a priority for policy makers? Answering this question requires looking beyond strict numbers of casualties and crashes to consider wider economic, health and well-being issues. Road danger is often cited as the main barrier to people cycling (Santacreu, 2018a) or letting their children travel independently. In other words, making streets safe would enable more people to walk and cycle more often, potentially saving time and money and choosing a cleaner and healthier option. A great potential for mode shift exists in dense urban areas where most trips are short enough to be walked or cycled. A focus on *urban* road safety is therefore twice beneficial: in addition to preventing a number of deaths and serious injuries, the unlocking of active travel options is at stake.

Despite numerous attempts to quantify the economic cost of road traffic crashes, to the author's knowledge none has included the wider economic impact of the fear of traffic. Research is needed to put a value on this fear and reveal the true scale of urban road safety benefits. Since the fear of crashes is a major burden in cities, it is natural to recommend measuring and monitoring it. While such metrics would not replace indicators based on casualty numbers, they could alleviate some difficulties associated with the comparability and statistical power of casualty figures.

Similarly, more efforts should be put into mapping and monitoring speeding on the entire urban road network. This is essential given the proven relationships between speed and crash risk (ITF, 2018b) and the contribution that speeding plays in making people feel unsafe on the streets. Technology could play a role and support such analysis. Be they from sensors on the roadside, satellites, drones or floating vehicles, comprehensive speed data may soon become available. Policy makers are encouraged to anticipate such innovation, the privacy concerns they raise, and the data sharing agreements they depend on.

As cities promote walking and cycling, one might wonder if such a modal shift could have negative consequences in terms of casualty numbers. In findings for this report, people walking and cycling are about ten times as likely as car occupants to be killed in traffic, for a given distance travelled. Yet in dense urban areas, once the risk of killing third parties is fully taken into account, the relative risk of various transport modes is fundamentally different. Simulating the impact of modal shift on casualty numbers, therefore, requires an extremely thoughtful approach. Arguably, one should not limit the scope of the simulation to casualties but include the broader public health impact of people being more or less physically active.

Our findings consistently point to the high relative risk experienced by users of powered two-wheelers (PTWs). This user group also causes a number of fatalities among other VRUs. Despite a number of caveats already mentioned, a shift from PTWs to other modes is most likely to reduce the number of traffic fatalities and potentially reduce the public health burden of physical inactivity at the same time. At the other end of the spectrum, buses are the safest way of travelling along the road network.

According to our results, a shift from public transport to cycling could lead to a rise in the number of people killed in traffic. This should be nuanced, however, by observation of the lower number of fatalities per unit of population in those cities where people cycle the most. In any case, one should bear in mind the strong body of evidence showing that the health benefits of cycling outweigh the risk of fatality (Santacreu, 2018a). The local air quality benefits of this modal shift should also be taken into account thus this report does not capture the entire spectrum of public health effects of mode shift. The Safer City Streets initiative, however, supports such a research effort by collecting mobility and casualty data, and by building capacity for better data collection techniques.

The report has highlighted wide performance gaps across cities and these numbers call for urgent political responses at all levels. Setting ambitious and timely road safety targets can help communities work together towards zero deaths and serious injuries in traffic. For this reason, it is recommend that local authorities set such targets.

Vulnerable road users; pedestrians, cyclists and riders of PTWs –account for eight out of ten fatalities in urban road traffic. As a result, road safety priorities in cities are specific to the protection of VRUs. These priorities include traffic calming, improved street design, speed limits and safer trucks.

Unfortunately, not all cities have the capacity as yet to measure the level of risk experienced by VRUs in urban traffic. Many countries also lack this capacity (Castro et al., 2018). The challenge is that such indicators require estimation of the total amount of travel with each transport mode within the city boundaries. Responsibility for this type of mobility data has traditionally been outside the remit of local government road safety teams, making it harder for road safety professionals to gain access. Yet mobility data often exist because they are fundamental to the elaboration of sustainable mobility plans. Cities should conduct standardised household travel surveys to better understand the roles of age, gender and deprivation in mobility patterns and road user risk. Cities should also undertake traffic counts to complement travel survey results. In both cases, significant capacity building effort is needed if cities are to collect robust, comparable data. National and international initiatives in this area would be particularly valuable. Synergies could thus be found between the road safety, sustainable mobility and physical activity policy agendas.

Working on fatalities alone, at the city level, means working with small numbers – not small in human terms, of course, but statistically small. Year-on-year changes in fatality numbers are rarely statistically significant; they cannot distinguish between a simple random oscillation and a trend. That is why most of the results presented here are computed on a five-year average basis. Such lack of granularity limits the power of analytical efforts. The use of serious injury data is therefore essential to the monitoring of road safety at city level.

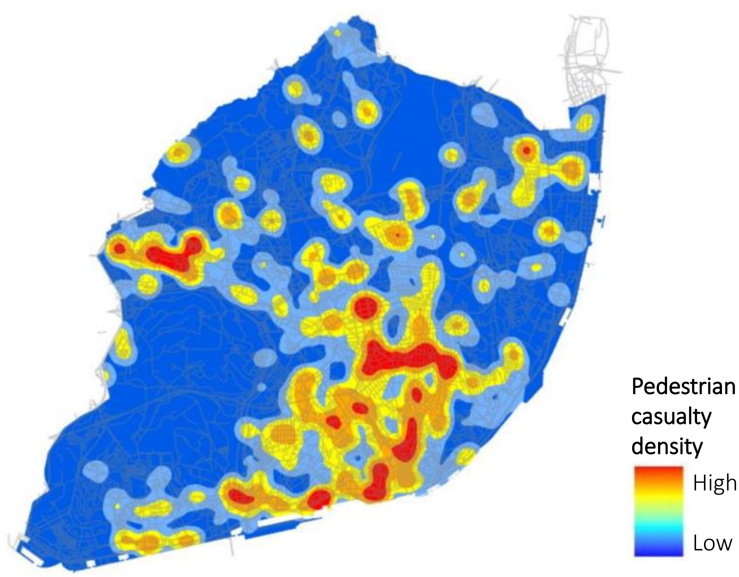
Injury data are not yet comparable between cities; therefore this report does not use them. Prone to under-reporting, official injury numbers may fluctuate in line with police resources, reporting channels and procedures, modal split and also with public attitudes to reporting. The support of the European Commission for the MAIS3+ injury severity standard, however, raises the hope that more cities will be able to make robust and comparable estimates of serious injury numbers.

Road Safety Governance: Case study of Lisbon, Portugal

Almost 3 million people live in the metropolitan area of Lisbon, which is made up of 18 municipalities. At the heart of this area, the City of Lisbon is home to over 500 000 residents. The figure has been steadily declining since the 1980s due to migration from the central urban area to the peripheral municipalities in the wider metropolitan area. According to the 2001 Census, between 1980 and 2000, the City of Lisbon lost more than 100 000 people – about 16% – to the peripheral municipalities (Balsas, 2007). The combined result of population outflow and the decline in birth and mortality rates has more than doubled the City of Lisbon's older population ratio, from 9.3% in 1960 (74 400 elderly people out of a general population of 801 000) to almost 25% in 2011 (136 000 elderly out of 552 700), and this trend in ageing population based in the City of Lisbon has since been amplified (OECD, 2015).

The ageing of the population has implications for pedestrian safety, in particular in the core city, where the majority of casualties have been occurring (Figure 19). According to the municipal administration, pedestrians aged 69 years and over account for 32% of all serious pedestrian injuries (CML, 2018).

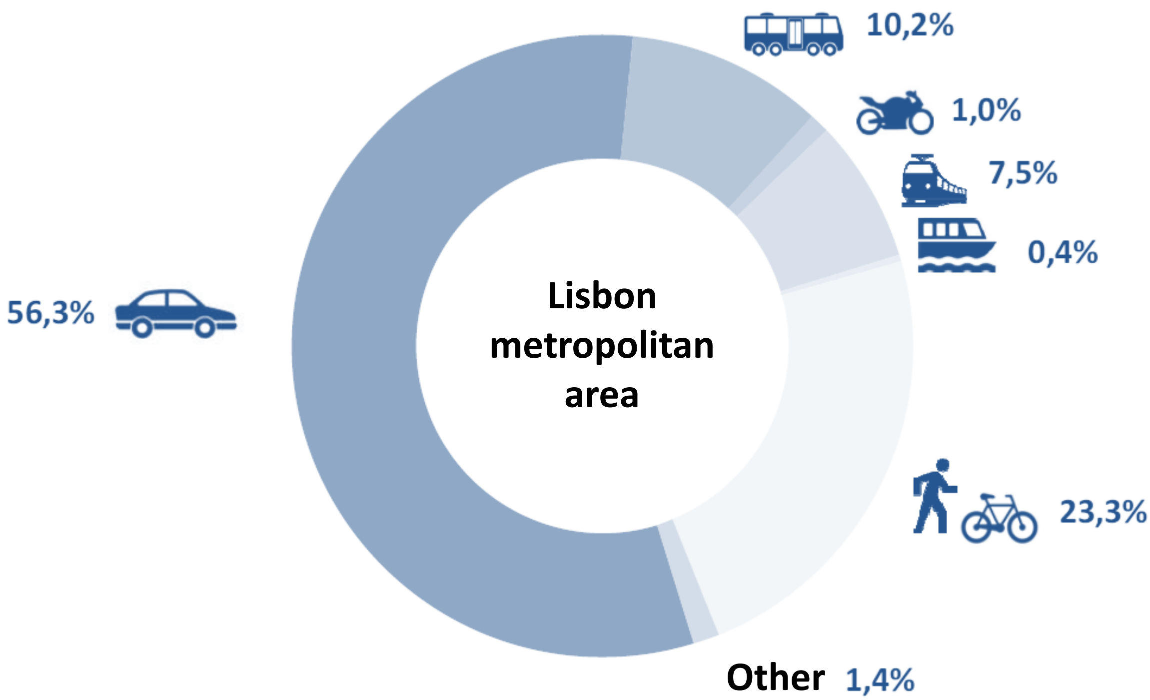
Figure 19. Lisbon pedestrian casualty heat map, 2010-11



Source: CML (2013), Plano de Acessibilidade Pedonal de Lisboa Via Pública, Vol. 2, p .89.

The majority of trips are made by car in the Lisbon metropolitan area, which inevitably creates a road safety challenge (Figure 20). Over-reliance on private vehicles is a result of poor land-use planning, which, combined with a lack of strong metropolitan governance and poor public transport options, has led to dramatic urban sprawl. Due to the large share and political influence of population living in peripheral municipalities, mobility policies in the Lisbon conglomeration have been directed by their aspirations to correspond to the wishes and needs of the large masses of the suburban population, who advocate for car-oriented strategies. This has made it difficult for local authorities to promote strategies aiming at developing sustainable transport options.

Figure 20. Lisbon metropolitan area mode shares, 2017



Source: INE (2018)

Nevertheless, over the last decade, the Câmara Municipal de Lisboa (CML), the municipal administration has been adopting strategies aimed at delivering tangible results in terms of improved pedestrian safety. These actions may have contributed, to some extent, to a significant drop in pedestrian fatalities in Lisbon City, from 1 631 in 1998 to 735 in 2015 (CML (Câmara Municipal de Lisboa), 2018). Factors behind this reduction are probably varied, and unfortunately have not yet been the object of specific research. The following sections identify the roles of various administrations and government agencies in improving safety performance in the city, as well as policies and actions that have allowed Lisbon to deliver safer urban environments.

National and sub-national governance

Overall the national government has an important impact on policies implemented on the local level through both its strategic influence and its funding participation. For instance, a recent national government decision to cut public transport subsidies raised discontent among local stakeholders due to concerns that it might lead to communities increasingly becoming reliant on private vehicles, with adverse environmental consequences and negative implications for road safety.

The leading national agency for road safety issues is the National Road Safety Authority (ANSR), which is part of the Ministry of Internal Affairs. The ANSR contributes to policy development in the field of traffic and road safety. It is responsible for planning and co-ordinating road safety policies in Portugal by developing national strategies and targets.

Through its National Road Safety Strategy, the ANSR defines strategic priorities and targets that are expected to be translated to and reflected at a local level through development of local road safety action plans. The latest National Road Safety Strategy, for 2016-20, was approved by the Council of Ministries in 2017. Within it the ANSR defines strategic priorities and objectives. The latest strategy includes the following targets for 2020 (ITF, 2018a):

- no more than 41 deaths per million inhabitants by 2020, representing a reduction of 56% compared to 2010 level
- no more than 178 serious injuries (MAIS3+) per million inhabitants by 2020, representing a reduction of 22% compared to 2010 level.

National road safety guidelines set out general but explicit goals that guide local authorities towards achieving higher safety performance on a local level. These may have contributed to a rapid drop in casualties in Portugal: 593 road fatalities were recorded in 2015, down 71% since 2000. With 5.7 fatalities per 100 000 population, the Portuguese fatality rate is now close to the EU average of 5.1 (ETSC, 2017). Naturally, other factors have contributed to this rapid decline, such as renewal of the vehicle fleet, with the benefit of new vehicle safety standards, as well as the development of a dense motorway network, a type of infrastructure that is known to be safer than other road types.

There is nonetheless a recognised need to align national road safety objectives and targets with strategies aimed at promoting a modal shift from cars to alternative transport modes. Portuguese national campaigns have raised awareness among pedestrians of the dangers they face in traffic. For instance, campaigns have promoted the wearing of reflective equipment by older age people when mobile in urban environments. While this can reduce fatality numbers in the short term, it does not address the root causes of road danger, which are the volume and speed of motor vehicle traffic, symptomatic of a car-dependant urban development. To achieve long-term goals of delivering safe and sustainable urban environments, a coherent narrative based on integrated transport and land-use policies needs to be developed.

Portugal is divided into 18 districts, which historically were its most relevant first-level administrative divisions. Districts still serve as the basis for some central administrative divisions, such as electoral constituencies and police and civil protection regional commands.

However, recent decentralisation policies of the national government have been aimed at shifting some responsibilities to a local level below the districts, thereby decreasing the importance of districts. Since 2003, Portuguese municipalities have been allowed to group themselves into inter-municipal communities (*comunidades intermunicipais*) and metropolitan areas (*áreas metropolitanas*), which has contributed to the reduced role of the districts. As part of this restructuring, in 2003 the Lisbon metropolitan area (Área Metropolitana de Lisboa, or AML) of 18 municipalities was established.

Until 2011, when the district governor position was abolished, administrative powers were fragmented between traditional district structures and the newly created metropolitan areas. For instance, the district of Lisbon and the district of Setubal had a jurisdictional overlap that interfered with the Lisbon metropolitan area authority. With their civil governors appointed by the prime minister, districts had most administrative powers, leaving metropolitan areas passive.

Even now this overlap between the district-level administration no longer causes problems, the AML remains poorly positioned to deal with the pressure of transport-related challenges, most notably in terms of developing a coherent mobility strategy for the metropolitan area, co-ordinating actions between agencies, delivering policy and providing accountability. The AML lacks the capacity to promote integrated and coherent transport strategies, as each municipality within the metropolitan area can choose to retain or relinquish its transport competencies. The result is visible in the varied orientations of mobility policies between the urban core of Lisbon and its peripheral areas, which support car-oriented strategies rather than enhanced walking policies. This territorial and administrative mismatch of responsibilities has a direct negative impact on road safety matters, which often are not co-ordinated between the municipalities.

Municipal and sub-municipal governance

The CML municipal authority is run by an elected municipal council led by a Mayor and made up of 16 councillors, along with an elected municipal assembly that monitors the council's activity. The city administration has over 8 000 employees spread across 15 municipal directorates and 46 departments. The departments cover a variety of city-related matters, such as education, housing, urban planning, culture and trade

In terms of transport policies, the CML is responsible for most mobility strategies and has a legal mandate to plan, build, manage and improve the network of roadways, pavements, crosswalks, public parking, bus stops, etc. It is also responsible for all matters related to traffic management and safety on this network, except for river bridges and the urban highway system.

Below the municipal level, Lisbon is divided into 24 boroughs (53 until November 2012). Boroughs are the lowest tier of local government in Portugal. They have a degree of political autonomy and are administered by elected representatives. The average population of each borough is around 21 000, twice as high as in the previous division, which simplifies interactions with the municipal level and enables capacity building in each borough on matters relevant to road safety.

Boroughs have responsibility for street cleaning, green spaces, markings on local roads, management of signs on local roads and other matters. While the whole city's transport and street network is planned and managed by the CML, the municipality has delegated maintenance responsibilities to the boroughs.

The CML works closely with boroughs for urban improvement. For instance, formal agreements established by the CML with the boroughs of Arroios, Beato, Belém, Benfica and Misericórdia has led to the upgrading of almost 150 pedestrian crossings. The CML provided funding, technical guidance and supervision, and the boroughs selected the target crossings, developed the designs and did all the construction, ensuring proper communication and consultation with local stakeholders along the way.

Leveraging public awareness and putting road safety high on the political agenda

After decades of planning, design and management culture that had led to a deep car dependency, Lisbon is going through a transformation as more space is being allocated to pedestrians and cyclists. At the same time, since 2014 the city has begun addressing its pressing ageing challenges in a comprehensive manner by deploying strategies in a variety of policy areas. Most notably, by adopting a Pedestrian Accessibility Plan, the city was able to achieve significant progress, elaborating a clear strategy with clear goals and guidelines supported by a strong and committed political consensus. This section details mechanisms through which the municipality of Lisbon has been able to make solid progress in aspects related to safety and accessibility.

Civic political discourse in defence of pedestrians ultimately encouraged the Lisbon authorities to advance on the accessibility and road safety agendas. As in many cities, public programmes leading to the reallocation of road space to pedestrians and cyclists were met by negative attitudes from car users. In this context, public awareness of the problems created in Lisbon by the car-centric model and by a lack of a consistent and coherent safety policy brought the subject into the political agenda and pushed forward development of specific programmes and actions with public support.

Lobbying by local and national non-government organisations (NGOs) has been instrumental in pushing the issue of pedestrian safety and accessibility into the Portuguese political agenda. Since 2005, after a number of highly publicised fatal crashes, the subject of pedestrian safety had attracted the attention of the local authorities. Similarly, organisation of car-free days advocated for by local communities and activists helped promote such themes as accessibility over mobility, walking and public health, and pedestrians' rights vs. drivers' rights (Ramos, 2012).

Using participatory budgeting to involve citizens in the decision-making process on citywide improvements

Since 2008, Lisbon has been one of the pioneering European capitals to adopt participatory budget cycles at municipal level (Lisboa Participa – Orçamento Participativo). This system enables citizens, community groups and NGOs to promote a variety of actions and programmes annually. A number of these proposals are then selected by popular vote for inclusion in the city budget, accounting for up to 5% of the city's total investment spending. Lisbon's participatory budget is an important element in stimulating citizen participation in municipal policies and a tool enabling citizens to indicate where improvement is needed (Allegretti & Antunes, 2014)

A proposal to enhance accessibility and eliminate physical barriers on several of Lisbon's central avenues was submitted to the participatory budget on the initiative of Diana Teixeira, a political graduate student who uses a wheelchair. Through her own initiative she conducted a full accessibility audit of Lisbon's central axis, composed of a series of major avenues, and submitted a proposal for the participatory budget. Eventually, the disability community supported her idea and campaigned actively for its success. The project won the most votes and turned into a major EUR 9 million improvement project, becoming a flagship of a profound change in the city's policies about transforming heavy traffic streets into a pedestrian-friendly environment.

Linking pedestrian accessibility and safety with the needs of an ageing population

The increasing share of elderly people in the population has underlined the importance of enhancing physical accessibility in the pedestrian environment and public transport networks. In particular, the poor quality of pedestrian crossings and pavements, as well as a lack of clear visual elements at bus stops, represented a significant barrier to access for senior citizens to various types of services. At the same time, the poor quality of the pedestrian environment has had negative implications in terms of pedestrian safety. For instance, members of many senior population groups were found to be at risk of being hit in traffic or injured in falls due to the poor conditions of the pavements (OECD, 2015).

In response to these challenges, promoting accessibility for all and improving the quality of the pedestrian network became focal priorities for the city of Lisbon. The City Council, during the administration of Mayor António Costa, decided to draw up a Pedestrian Accessibility Plan. The idea for development of the plan was approved in 2009, along with an ambition to incorporate a pedestrian safety dimension within its scope. The plan took four years to develop, from 2009 to 2012. It was unanimously approved by both the City Council and City Assembly, becoming a key driver for pushing road safety policies forward in the city.

The plan incorporated a diagnosis of the situation, identified opportunities for change, included general guidelines (for day-to-day decisions) and listed 100 actions that had to be taken by the end of 2017. As of 31 December 2017, the plan was 82% completed.

The plan's development relied heavily on input from city residents and especially considered those most vulnerable to accessibility barriers. Thus a high value was put on collection of quantitative and qualitative data on the needs, difficulties and preferences of persons with disabilities and the elderly. Throughout the development of the plan, public consultation sessions were convened so citizens could share their experiences and needs regarding the use of crossings, pavements and access to public transport.

Figure 21. Pavement extensions in Lisbon

Note: Pavement extensions reduce the distance pedestrians have to cross and help reduce vehicle speed.

Source: Alexandre Santacreu (2018).

Consequently, the essential objective of the Pedestrian Accessibility Plan was to improve the risk-free walkability of the city. The main focus of the plan in public spaces has been pavements, crossings, bus stops and reserved parking for people with disabilities. The city thus aimed at reducing barriers to walking, adapting existing environmental design and raising awareness among pedestrians and road users, all of which are measures to improve autonomous access to services and comprise a starting point for reducing social isolation.

Putting safety and comfort considerations for elderly population groups at the heart of the accessibility plan helped the CML promote change regarding a sensitive issue: the use of new materials instead of traditional cobblestones on pavements. The matter generated intense public debate, as cobblestones are associated with Lisbon's visual identity. However, cobblestones make pavements irregular, uncomfortable and slippery, reducing safety and accessibility. In this context, prioritising safety and accessibility allowed the CML to justify the use of alternative materials when making changes to the pavements.

Figure 22. Street markings to signal 30 km/h speed limit, Lisbon

Note: Street markings are part of the effort to lower the speed limit to 30km/h and encourage cycling on residential streets.

Source: Alexandre Santacreu (2018).

Approval of the plan gave the CML a clear yearly commitment regarding financial responsibility: it is to allocate at least 3% of the city's public works capital investment on improving accessibility. Management mechanisms are being put in place to fully and clearly demonstrate that this commitment is fulfilled. Implementation of the actions in the plan is supervised by a special department created to co-ordinate, motivate and provide technical guidance to all stakeholders involved in urban improvement across Lisbon.

Box 3. Application of a pedestrian crossing model and traffic light management

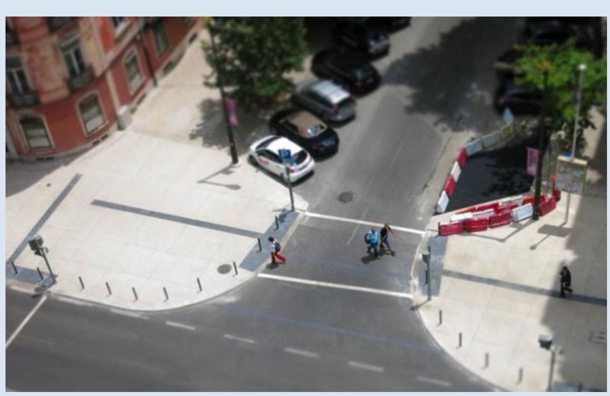
In Lisbon, fear of traffic congestion has traditionally led to two decisions in the field of traffic light management. First, the time pedestrians are given to cross the street has been calculated not with their real needs in mind (especially for the elderly) but considering the needs of moving cars. Second, at many intersections, turning on red has been allowed (i.e. cars can turn into an intersecting street and go over a crosswalk when it is green for pedestrians). Both decisions can make crosswalks more dangerous for pedestrians, especially those who walk more slowly or have vision problems.

As part of efforts to enhance accessibility and safety, at Alexandre Herculano Street the city reduced the crossing distance and the curve radius on all corners. Green time for pedestrians remained the same, but it was enough for the smaller distance. Before the intervention, pedestrians had to cross the intersection at a speed of 0.51 m/s. Now they can cross the smaller distance at 0.12 m/s (Portuguese mandatory standards require the crossing speed to be no more than 0.4 m/s).

In addition, this measure had a traffic calming effect. Drivers approach intersections at slower speeds, and sight lines are wider. Pedestrians feel safer (+18%) and less pressured by drivers to walk faster (-14%). These measures were applied in 2016 and there has been no increase in traffic congestion.

Figure 23. Before pavement extension and raised treatment at a pedestrian crossing

Figure 24. After pavement extension and raised treatment at a pedestrian crossing



Photos: Pedro Alves Nave (CML)

Source: CML (2013)

The use of a variety of geographic information system (GIS) analysis (Box 4) allowed the Pedestrian Accessibility Plan team to assess and carefully analyse specific road safety problems and to prioritise locations and investments for road safety actions. The team thus identified the biggest barriers to better mobility in the city: motor vehicles and lack of space for pedestrians (including pavement obstructions in many places). The creation of a GIS database with all traffic crashes involving pedestrians enabled them to clearly demonstrate that:

- Senior citizens are at a considerable disadvantage due to reduced mobility and vision.
- Barriers to accessibility create safety problems for all.
- Crosswalk adaptation must both eliminate barriers and improve traffic safety.

Box 4. Geographic Information Systems

Knowing where crashes occur, and in what circumstances, is valuable information for cities. It helps them to diagnose road safety problems, prioritise interventions and evaluate projects. A research project, in collaboration with the National Civil Engineering Laboratory and in co-operation with Lisbon city hall and police, was able to collect and geo-reference four years of accidents in Lisbon (2004 -07) (Vieira Gomes, Cardoso and Carval, 2008).

Under the Pedestrian Accessibility Plan, the effort was resumed, led by the municipality in co-operation with the police and the National Road Safety Authority. The current database contains details of all collisions involving pedestrians since 2004. Its scope was initially limited to crashes involving pedestrians, but it now collects information on all crashes. Data collected by the International Transport Forum (ITF) through the Safer City Streets network show pedestrians alone making up 45% of all road fatalities in Lisbon (Santacreu, 2018b).

In addition to the database SINAL of crash information, the municipality developed two other GIS databases:

- SIGA: Accessibility Management System, a detailed accessibility audit of pavements and crosswalks. For each barrier a solution is indicated, with descriptions of necessary actions and respective cost estimate. This has enabled accurate cost estimates and integration of necessary actions in several public works that were not accessibility related.
- MAPPE: Pedestrian Potential Map, a model that predicts pedestrian traffic intensity. It provides predictions based on population density (2011 census) over 2 000 generators of pedestrian traffic (public facilities, public transport stations, etc.) and type of street.

All three GIS tools are available every day to officials in multiple city departments and boroughs.

Source: CML (2013).

Putting a strong focus on capacity building to support citywide accessibility and safety actions

Co-ordinating implementation of the actions listed in the Pedestrian Accessibility Plan was the role of a dedicated task force, the Pedestrian Accessibility Plan team. It was made up of ten people, from the fields of architecture, civil and traffic engineering, psychology, ergonomics, geography, tourism and communications. An important part of its mission was capacity building through the provision of training, technical support and tools to support decision making and design development. The capacity building effort was aimed at all stakeholders involved in implementing the actions in the plan (Box 5).

The team was set up to co-ordinate, motivate and support municipal implementation efforts. A variety of city departments rely on the team's technical support, which was a key to leverage across various city departments. By decision of the mayor, the team evolved into a permanent division, integrated in the Public Space Department.

Box 5. Capacity building steps to traffic calming

Government officials may reject new political priorities and working methods, especially if they are not familiar with the new techniques. After decades of car-centric street design, many traffic calming features tend to be rejected. Pedro Homem de Gouveia, co-ordinator of the Lisbon Pedestrian Accessibility Plan, shares his views on capacity building in this context:

- Formal training on traffic calming solutions is appreciated by the most motivated professionals. It is essential to raise the profile and the legitimacy of the topic. However, due to everyone's competing work pressures, training is rarely attended *en masse*; it isn't enough in itself.
- On-demand technical support is more likely to respond to the actual needs of colleagues who cannot attend formal training. In addition, this is a solution to disseminate a message beyond the barriers of organisational silos. In Lisbon, flyers and other free hand-outs were distributed, with the contact details of the Pedestrian Accessibility Team.
- Design templates act as legitimate guidance for engineers to follow. It helps them upgrade pedestrian crossings and bus stops, and create pavement extensions (bulb-outs), traffic calming measures, continuous raised pedestrian crossings, etc. Municipal teams are not immune to the fear of litigation in case of on-street incidents, which lowers their ability to innovate. Design templates not only make engineers' work easier, they also address this fundamental issue of responsibility.
- Ownership of the new political priorities and working methods is not centralised in a given department. If it were, other departments would be less supportive and wouldn't contribute. Instead, it is best to distribute ownership across all relevant departments. In the Lisbon municipality, pedestrian accessibility design templates were adopted and implemented by a range of departments, such as Public Space, Public Works and Local Intervention.
- Communication and social media are key to positive reinforcement, used to enhance adoption of innovative principles despite the natural conservatism of large organisations.

Source: ITF based on Interview with Lisbon Pedestrian Accessibility Plan co-ordinator.

Developing clear technical guidance and standards to support effective and coherent urban interventions

To provide technical guidance and minimise inconsistency the Accessibility Team elaborated city standards, referred to as Accessibility Models, that collect, systematise and illustrate Portuguese legal and regulatory requirements for urban design. These models cover all factors related to physical accessibility, such as relation to nearby public transport stops, drainage, lighting, signal timings and type of pavement. Accessibility Models are based on good international practice and serve as a guide for designers and contractors, helping them take urban design requirements into account. Models have been developed and made available online for pedestrian crossings, bus stops, pavements and traffic calming measures. Tried and tested design solutions are integrated in a template for Tendering Pedestrian Accessibility and Safety Construction.

Accessibility Models are based on a categorisation of crossings and pavements by type, location and design, based on GIS analysis. For instance, crossings are divided into categories such as “uneven crossings”, “crossings with traffic lights” and “pedestrian crossings”. For each type of crossing, specific accessibility standards and requirements were developed. The surface pedestrian crossing model includes requirements and standards in terms of visibility, drainage, lighting, pavement, road signs, traffic timing and other factors. For instance, for traffic crossings, there is a requirement that the green crossing signal be open for sufficient time to allow the whole track to be crossed at a speed of 0.4 m/s. To facilitate the crossing of the visually impaired, the model requires traffic lights to be equipped with mechanisms that emit sounds and vibrate.

Development of Accessibility Models covering all factors related to physical accessibility was a key element in making sure the decisions of a variety of city departments and stakeholders were coherent and had a positive impact on accessibility. This allowed the city to treat all public works, executed by various departments, as an opportunity to implement established guidelines and thus improve crosswalks and pavements across Lisbon, rather than act in a limited part of the city.

To increase uptake of the models, the Pedestrian Accessibility Plan Team identified priority locations where the impact of integrating Accessibly Models was demonstrated (Box 3). This allowed the team to:

- show stakeholders that the models work
- gain political support for the model uptake
- educate designers and end users
- test the results of the models with vulnerable groups.

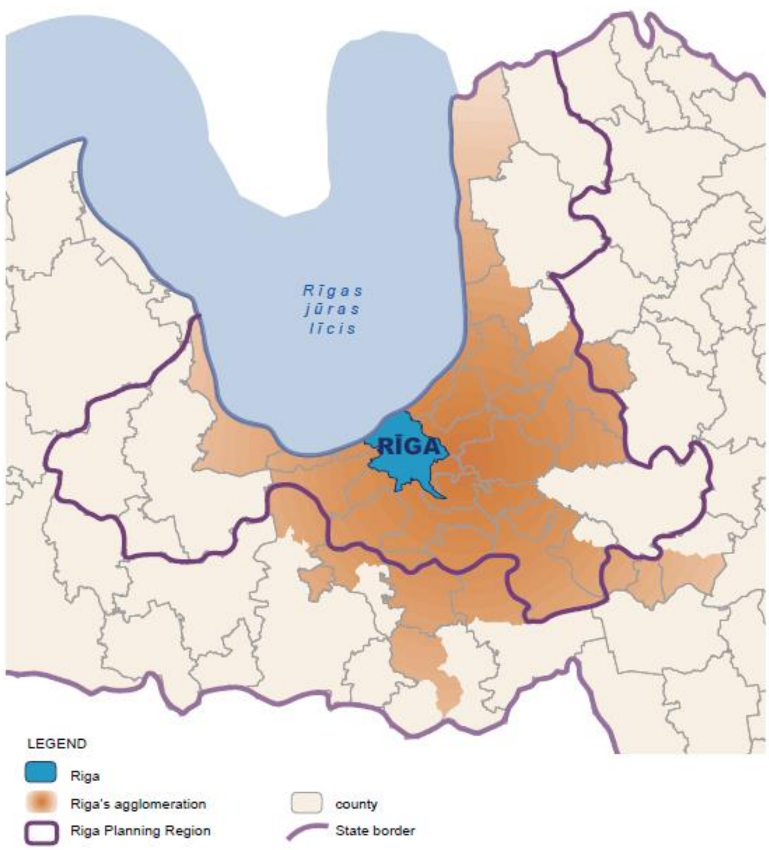
As a result of high model uptake, between 2014 and 2016 city departments and boroughs intervened at almost 500 crosswalks across the city, ensuring accessibility and putting in traffic calming measures.

Road Safety Governance: Case study of Riga, Latvia

Riga, the capital of Latvia, concentrates around 30% of the national population with 700 000 inhabitants. The wider Riga agglomeration, i.e. the City of Riga and surrounding municipalities, is home to almost 1.15 million people, almost 50% of the population of Latvia (Figure 25). It is important to note that the Riga agglomeration is not a formal division but is based on the inter-relationship between Riga and surrounding municipalities, which extends well beyond the so-called Riga Planning Region, discussed in the next subsection. The agglomeration comprises the commuting area: large shares of the population commute to work daily in the city of Riga from the surrounding suburban belt.

Latvia has experienced population loss in recent decades in terms of demographics: between 2010 and 2017, its population declined by 8.7%, from 2.12 million to 1.93 million in 2017 according to the Central Statistical Bureau (CSB) of Latvia (CSB, 2019). In the Riga agglomeration the population decreased by 3.6% in the same period. This is due to its importance as a hub of economic and financial activity, which allowed Riga to retain the prime-aged working population (OECD, 2017).

Figure 25. Riga and its region



Source: Riga City Council (2014)

However, within the agglomeration, the city of Riga itself lost population, mostly to surrounding municipalities – the so-called suburban belt (CSB, 2019). One of the most important problems Riga faces today is local migration of middle-class people to surrounding municipalities along main roads (Jansons, 2011). Since 1995, new residential areas have been rapidly appearing around the city on former agricultural land. These areas became a major magnet, not only for population from more remote areas of the Riga region but also from the city itself. Thus in the last decade, previously rural municipalities, now suburban areas of Pierīga (Riga agglomeration), have undergone the most population growth, while the city of Riga and the more remote areas of its region have lost population, increasing territorial imbalance.

The population redistribution has led to changes in the region's mobility patterns. The importance of the road network and private transport has increased at the expense of rail and public transport. A long-standing tradition of car-oriented planning, inherited from decades of Soviet urban planning, contributed to this trend. The tradition remained even after Latvia gained its independence in 1991. As a consequence, the city has experienced a rapid increase in the level of motorisation, which has been accelerating in recent years. Between 2000 and 2010 the number of private vehicles in Riga proper increased by 60%, but the inflow of vehicles from surrounding areas doubled (OECD, 2017).

At the same time, insufficient provision of public transport has exacerbated over-reliance on private vehicles. On the European Union's 2015 Quality of Life Survey, only about 67% of respondents stated that they were satisfied with the public transport in Riga city, down by 14 percentage points since 2012. Only 38% of respondents indicated that they used public transport daily (European Commission/UN Habitat, 2016). About 15% of the population of Riga proper has no easy access to public transport, and has to walk more than five minutes to the next bus or tram stop (European Commission, 2015; European Commission/UN Habitat 2016). In surrounding municipalities of Riga, the share can be much higher. As a consequence, the Sustainable Development Strategy of Latvia to 2030 highlights the need for co-ordinated planning of transport infrastructure, public transport and urban development (Riga City Council, 2014).

These factors have had important implications for road safety. Among European Union countries, Latvia has one of the highest road mortality rates, with 9.5 road deaths per 100 000 population per year (European Commission, 2015). A joint study by the Latvian Road Traffic Safety Directorate (CSDD) and specialists from the University of Latvia showed that the majority of crashes happened in the Riga area. Some 42% of the total number of road traffic crashes involving casualties were registered in the City of Riga in 2017. Table 4 summarises the causes of road crashes in Riga between 2014 and 2017. According to estimates, the most severe crashes in Riga involve the most vulnerable of road users – pedestrians.

Table 4. Distribution of road traffic crashes by type in Riga

	Accidents					Deaths					Injured (total)					Seriously injured				
	2014	2015	2016	2017	%	2014	2015	2016	2017	%	2014	2015	2016	2017	%	2014	2015	2016	2017	%
Accident with pedestrians																				
	555	**522**	**500**	**523**	**32.2%**	**18**	**15**	**8**	**15**	**63.6%**	**573**	**533**	**512**	**537**	**28.6%**	**30**	**35**	**51**	**34**	**50.8%**
Accidents involving at least two vehicles																				
Collision	527	520	593	589		11	4	3	0		748	669	818	794		12	25	19	13	
Crash between vehicle and bicyclist	153	181	174	147		2	2	0	0		157	184	176	150		3	5	7	5	
Accident with parked vehicles	33	27	30	23		0	0	1	0		40	33	39	29		0	0	5	0	
Total	**713**	**728**	**797**	**759**	**45.9%**	**13**	**6**	**4**	**0**	**26.1%**	**945**	**886**	**1033**	**973**	**51.0%**	**15**	**30**	**31**	**18**	**31.9%**
Single vehicle accidents																				
Unknown	241	219	201	208		0	1	0	0		250	229	213	214		0	1	2	2	
Rollover, leaving road	57	85	94	110		0	2	0	2		59	100	95	113		0	9	5	1	
Accident with obstacle	47	52	67	45		3	0	1	0		57	61	77	63		5	9	8	7	
Accident with animals	1	0	1	1		0	0	0	0		2	0	2	1		2	0	0	0	
Total	**346**	**356**	**363**	**364**	**21.9%**	**3**	**3**	**1**	**2**	**10.2%**	**368**	**390**	**387**	**391**	**20.4%**	**7**	**19**	**15**	**10**	**17.3%**
Overall	**1614**	**1606**	**1660**	**1646**	**100%**	**34**	**24**	**13**	**17**	**100%**	**1886**	**1809**	**1932**	**1901**	**100%**	**52**	**84**	**97**	**62**	**100%**

Source: CSDD (2018a)

Significant progress has been made in terms of road safety performance in the last decade, with the number of road deaths down by more than 70% between 2000 and 2011 in Latvia as a whole. This reduction is due to implementation of a variety of measures, such as use of speed cameras, systematic auditing of road infrastructure, road safety campaigns and development of cycling infrastructure. Nevertheless, since 2011 road mortality rates have stagnated. Thus important challenges remain to be tackled so that Riga and Latvia can reach their national targets of reducing fatalities by 50% by 2020 (European Commission, 2015). The following sections delve into governance structures of road safety and further explore specific policies and mechanisms that were introduced to improve road safety performance in the city of Riga.

National and sub-national governance

The main legislation governing road safety in Latvia is road traffic law. It sets out the main principles and governance bodies for the organisation of road traffic and the responsibilities of different administrative levels.

The Ministry of Transport, as the leading state institution in the transport and communications sector, is the main national authority responsible for road traffic. It organises and co-ordinates the development and implementation of national policies and monitors compliance with laws and regulations concerning road traffic safety.

The ministry's responsibilities include:

- policy making in the transport and communications sectors: preparation of draft policy planning documents
- monitoring the implementation of the measures provided for in the planning documents
- drafting of legislation in the field of transport and communications
- planning of budgetary programmes to be included in the annual budget law
- supervision of subordinate institutions in the transport sector.

The Ministry, in co-operation with other relevant institutions, co-ordinates the Road Traffic Safety Plan: a medium-term policy planning document identifying objectives, guiding principles and priorities regarding road safety improvements. The latest such plan covers 2017–20. It establishes targets of halving the numbers of fatalities and of severely injured persons in road traffic accidents by 2020, from the 2010 levels. The plan envisages specific lines of action to improve road traffic safety, determining the responsible institutions, implementation deadlines and the necessary financing.

The Latvian Road Traffic Safety Directorate (CSDD) is a separate national agency with its own responsibilities and tasks regarding road traffic. It is in charge of registering vehicles, granting driving licences, performing road safety audits and supervising road infrastructure. The CSDD is also in charge of monitoring the evolution of road safety performance in the country and identifying needed improvements in road infrastructure and road user education. Among other responsibilities, it is implementing the fixed speed camera project and a project on deployment of fast charging stations for electric vehicles.

Latvian State Roads (LSR) is another national road administration entity. LSR has responsibilities over roads that cross municipal borders. LSR organises and controls road network design, construction, repairs and maintenance, and approves any changes related to road signs. For instance, if municipal authorities envisage installing a new sign on a road belonging to LSR, they need to seek its approval. LSR also monitors traffic organisation and ensures that the location of the technical means for such organisation meets the requirements of the mandatory applicable standards in Latvia and other regulations.

Latvia is divided into five planning regions: Riga, Courland, Semigallia, Vidzeme and Latgale. These regions, within the scope of their competence, ensure planning and co-ordination of regional development and co-operation between local government and other parts of the administration. In accordance with the Law on Regional Development, the Riga planning region as an institution is a derived public entity supervised by the Ministry of Regional Development and local government. Its decision-making authority is the Riga Planning Region Development Council, whose 18 members are appointed at a meeting of all heads of municipalities in the planning region.

Overall, the Riga planning region provides a discussion platform for most municipalities in the area. However, some municipalities in the Riga agglomeration belong administratively to other planning regions. Hence the Riga planning region does not include all municipalities whose residents commute to Riga. The Riga agglomeration, being a key driver of growth and employment in Latvia, thus lacks an adequate governance structure, as no formal governance arrangement covers the entire area.

Municipal and sub-municipal governance

Each municipality is responsible for traffic organisation and sign location. Municipalities must ensure the construction, reconstruction, maintenance and illumination of streets, roads and squares, which means supervising monitoring and co-ordinating their work to solve traffic safety problems. In the case of national roads that pass through Riga city, maintenance is provided by the Riga City Council Traffic Department, with co-financing from LSR.

Below the municipal level are bodies called executive directorates, which have responsibility over the maintenance of some residential courtyards built on municipal land. The three executive directorates in Riga are Riga Austrumu, Riga Pārdaugavas and Riga Ziemeļu. Apart from street maintenance, executive directorates make decisions on inner repairs of housing blocks, green space and gardens.

Promoting dialogue and co-ordination of actions related to road safety

As a way to co-ordinate programmes and actions related to road safety among various stakeholders in Riga, the Traffic Co-ordination Advisory Council was established. It serves as the main platform for discussion of actions related to road safety. It is convened by the Riga City Council Traffic Department, in accordance with Traffic Department regulations. Stakeholders represented on the council are:

- Riga City Council Traffic Department (RDSD)
- Road Traffic Safety Directorate (CSDD)
- Latvian State Roads (LSR), a State Joint Stock Company
- Latvian State Police
- Riga municipal police
- Rīgas satiksme, the municipal limited liability company.

Local community groups are allowed to make suggestions to the council via official letter or proposal. In some cases, groups such as local motorist unions or biking associations are invited for discussion.

The council meets every three or four weeks to discuss issues related to road traffic and safety. The questions discussed might include proposals on changing traffic organisation on particular streets; putting in place new infrastructure, such as public transport stops; or installing traffic calming devices, such as speed humps or raised crosswalks. The council is considered an effective way to co-ordinate actions and take into account suggestions from a variety of stakeholders when implementing local programmes with a potential effect on road safety.

Speed enforcement through introduction of speed cameras

The Latvian authorities recently set up a large number of speed cameras as a way to enforce legal speed limits and thereby improve road safety. The number of speed cameras installed each year is decided by the Ministry of Transport and based on available financial resources. By the end of 2018 the ministry expects to have installed 100 fixed cameras across Latvia. There are plans to install even more speed cameras in the coming years and to also use average speed cameras. The selection of camera location is the responsibility of the CSDD, with input from Latvian State Police, LSR and municipal administrations.

The main goal of installing speed cameras is reducing the number of speed violations and traffic accidents. Before the speed cameras were put in, road signs informed drivers about permitted driving speed and the coming installation of the cameras.

The positive effect of speed cameras on residents' driving behaviour has been proved many times – there have been no lethal accidents in areas where speed cameras have been installed in recent years. A CSDD representative said that while fixed speed cameras were important to road safety, portable speed cameras were also essential, along with public education and infrastructure upgrades. Thus, aside from stationary speed cameras, Latvian State Police still use mobile speed cameras procured in 2008.

In Riga, speed cameras have been very efficient in enforcing traffic safety rules. Overall, there has been a reduction in fatalities at locations where cameras were installed. Within half a year, in places where speed cameras are located, on average car accident numbers have dropped by 42%, the number of injured victims by 21% and there are no deaths recorded (CSDD, 2018b). The CSDD reports that the speed of road traffic flow has decreased in places where speed cameras have been deployed.

Developing cycling infrastructure

Since 2008 the number of people using cycling as an alternative transport mode has been increasing. It is estimated that the city of Riga saw an increase of cycling uptake by five percentage points between 2008 and 2015. In 2013, for instance, 18.2% of Riga residents travelled by bike at least once a week (Riga City Council, 2015). The increasing popularity of cycling has raised a variety of questions related to the availability and quality of cycling infrastructure in the city and has drawn the attention of the general public and policy makers to cycling safety.

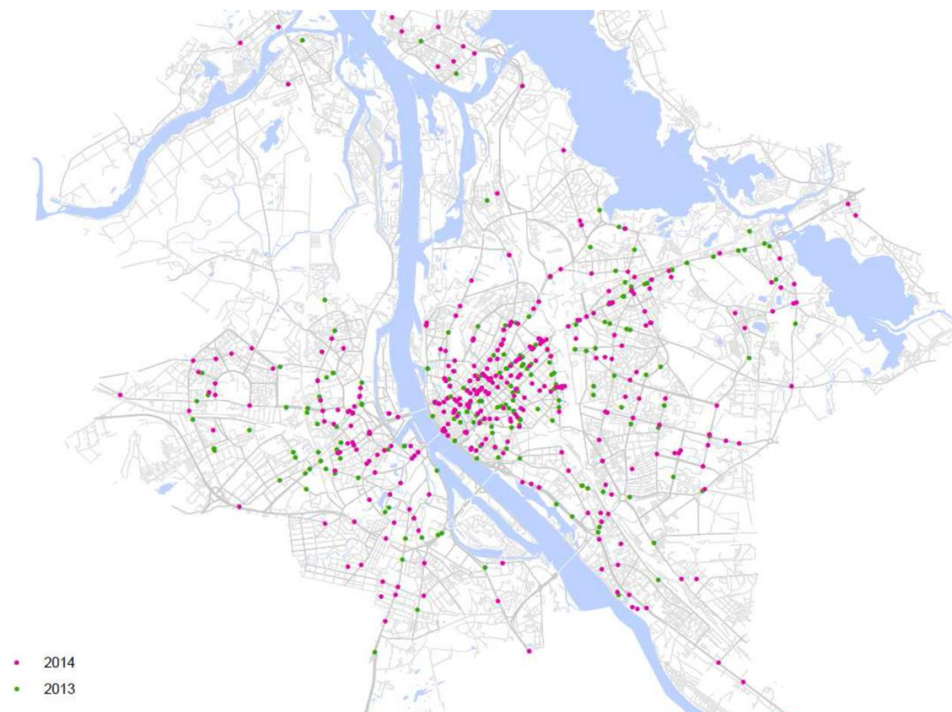
In the absence of adequate cycling infrastructure, cyclists use the pavement which affects the safety for both cyclists and pedestrians. Moreover, lax speed limit enforcement pushes cyclists to use the pavements for safety reasons. According to counts carried out by the Latvian Cyclists Association, in 2012 only 13% of cyclists preferred to drive on the streets while 87% chose pedestrian or cycling paths (Riga City Council, 2014). Until 2016, regulations allowed the use of pavements because they did not specifically define the place of cyclists in the hierarchy of road users. Since 2016, however, Latvian road traffic regulations have allowed cyclists to drive on pavements only when there are no dedicated lanes or when cycling on a carriageway is considered dangerous due to weather conditions or traffic intensity. In general, cyclists must use a bicycle lane, bicycle path, or footway and bicycle path, moving in the relevant direction as close to the right side as possible. However, despite the disincentives in the new regulations, cyclists continue to use pavements fairly frequently. This makes walking and cycling not only unsafe, but also inconvenient, slow, unpleasant and unfeasible in much of Riga city.

With the increased popularity of cycling, activist interventions advocating for enhanced cycling infrastructure in the city of Riga have been on the rise. These interventions, usually illegal, are aimed at highlighting how streets could be adapted by reallocating space now used by cars. For instance, in 2014, urban activists adapted the main artery, Brīvības Iela, to show that dedicated cycling lanes would not only make the street safer but also make more space available for all users without necessarily causing more traffic (O'Sullivan, 2017). Latvian campaigners argue that such forms of activism have proved to be an effective driver of change in the city.

As a response to increasing civic activism and rising shares of bicycle use, in 2015 the Riga City Council Traffic Department commissioned a full-scale strategic plan to improve cycling infrastructure. This Riga City Cycling Development Concept is a planning document that defines the vision, purpose and development of cycling infrastructure in the city. It is based on three main elements: (1) cycling infrastructure; (2) cycling planning and management, and (3) cycling promotion and education.

With the increasing popularity of cycling, crashes involving cyclists also gradually increased (Figure 26). The Cycling Development Concept was based on preliminary analysis of crashes involving cyclists across the city. The analysis of road traffic crashes showed that crashes involving cyclists were strongly concentrated in the city centre and on the main radial roads, pointing to the locations where measures to improve road safety were needed. Thus, the first actions to improve cycling infrastructure involved central Riga and the main arteries.

Figure 26. Road traffic crashes involving cyclists in Riga, 2013-14



Source: Riga City Council (2015).

The Cycling Development Concept prompted realisation of the first pilot projects, which gradually gained acceptance among the general population. Within the scope of the concept, attention has been paid to improving existing infrastructure, e.g. reducing pavement borders, doing street cover repairs and improving traffic organisation. New cycling tracks have been put in place to accommodate demand.

On some streets, design of cycling lanes includes separating high-speed traffic and cycling flows and installing median barriers to provide a safer environment (see photos below). Additionally, parking bays between the cycle track and the traffic lanes make cycling lanes more attractive and safe to use.

Figure 27. Cycle lane with light protection from motor vehicle traffic, Riga

Source: Alexandre Santacreu (2018).

Figure 28. Cycle lane with advanced stop line at a signalised intersection, Riga

Source: Alexandre Santacreu (2018).

On the streets where the cycle track is separated from the road only by the curb line, traffic intensity needed to be reduced. On one major artery, the introduction of a recommended cycling lane prompted a new speed limit of 30 km per hour. However, so far there this has been imposed on only one street.

Conclusions from road safety governance case studies

In Lisbon and in Riga the process of improving road safety was still in its infancy at the time of the authors' field work in 2017 and 2018. Since then, Lisbon has started work on a road safety action plan. In both cities, there still is a lot of room for improvement in land-use planning, public transport, road and rail networks and provision of better facilities for cyclists and pedestrians. Notably, to achieve long-term goals for delivering safe and sustainable urban environments, a coherent narrative based on integrated transport and land-use policies needs be developed. The main lessons that can be drawn from the road safety stories of Lisbon and Riga and provides recommendations on advancing good governance for delivering effective road safety policies are mentioned below.

Gaining political momentum for the initiation of road safety policies is imperative for meaningful change. Both case studies show the considerable importance of politics and a capacity for successful creation and implementation of road safety policies. Successful implementation requires not just the political momentum to initiate policies to promote road safety, but also the enforcement of legislation in practice. In the cases of Riga and Lisbon, the first step was to alter the way officials approach change. Road safety had not been a priority for local officials so local and national NGOs, as well as activist groups, pushed the issue of safety onto the political agenda through local programmes and interventions. Thus, civil society is essential to keeping road safety on the agenda, especially when there is a lack of political commitment. Both cases show that strong leadership is needed to incentivise and co-ordinate the actions of stakeholders, including ministries, local authorities, road agencies, parliamentarians, politicians and civil society.

Integrating road safety practices with wider development policies has demonstrated successful outcomes and should be continued. The case of Lisbon showed the importance of integrating road safety into wider societal policies and avoiding the tendency towards "silo thinking" that happens in many countries. There is much to gain in addressing road safety and environmental concerns together, as the fights against road crashes and pollution have many common levers. In the case of Lisbon, particular emphasis has been put on physical accessibility and the quality of the pedestrian environment, due to the wider demographic challenges of an ageing population. Linking the needs of the senior population to pedestrian safety and accessibility has been crucial to improving accessibility in the city and reducing barriers to walkability. Most notably, through the adoption of a Pedestrian Accessibility Plan, the city was able to achieve significant progress by elaborating a strategy with clear goals and guidelines supported by a strong and committed political consensus. As this case study shows, a key element that allowed implementation of the plan was a specific focus on capacity building. A special task force was established to facilitate citywide co-ordinated implementation of the plan through training, tools and technical support. This allowed them to co-ordinate, motivate and support municipal efforts in implementation of different actions and reduce the fear of the unknown as well as the fear of litigation.

In Riga's case, local authorities have given particular attention to enforcing speed limits and enhancing cycling infrastructure. Introduction of speed cameras with the support of multiple levels of government has helped reduce the number of speed violations and traffic accidents in the last ten years. The new cycling concept developed by the city of Riga prompted realisation of the first pilot projects and introduction of dedicated cycling tracks, which have had positive effects on cycling safety.

Using technical analysis and public consultation will highlight important focus areas, which identify needs for road safety improvements. In all the aforementioned actions, preliminary technical analysis of the locations where the most crashes occur was crucial to making effective plans and identifying the biggest barriers to improving road safety in general. This information has been valuable to diagnose safety problems, prioritise interventions and evaluate projects. In short, good data are needed to monitor progress towards targets and demonstrate accountability. The experience of Riga and Lisbon also illustrate the importance of taking into account the opinions of the various stakeholders in the decision-making process. While in Lisbon the development of the Pedestrian Accessibility Plan relied heavily on input from city residents, especially the most vulnerable to accessibility barriers, in Riga the co-ordination of actions related to road safety was largely promoted through a dedicated Traffic Co-ordination Advisory Council.

Improving vertical and horizontal co-ordination between government levels will foster stronger collaboration and is central to improving road safety performance. At the federal/national level, competences are often limited, so it is important to strongly engage local agencies, including local road authorities and police agencies, in actively committing to road safety. This may require allocating adequate funding to local agencies.

The potential benefits of co-ordination across local governments within the metropolitan areas of Lisbon and Riga are receiving increased attention. Urban sprawl and fragmentation of public transport planning create car-dependent communities, which in turn make it harder to develop road safety policies addressing car traffic speed and volume. Experience across OECD countries shows that Metropolitan Transport Authorities (MTAs) are crucial to enhancing integration between transport and land-use planning. An MTA that covers the whole commuting area can enable co-ordination among jurisdictions at all territorial scales and reduce negative implications of urban sprawl. MTAs can effectively contribute to attaining national policy goals (e.g. on health, environment, inclusiveness), promote integrated land-use and transport planning, and thereby facilitate improved road safety performance.

Adopting and mandating Sustainable Urban Mobility Plans (SUMPs) and/or road safety action plans that are well aligned with national objectives has proven effective for road safety improvements in metropolitan areas. SUMPs can foster balanced development of all relevant transport modes by including strategies aimed at discouraging private car use through development and promotion of public transport and less polluting modes, including car sharing, electric vehicles, cycling and walking. They also can include guidelines for the organisation of on-street parking and public car parks, and incorporate matters such as access to transport for all and road safety.

A good example of governance in this policy area is the Transport for London (TfL) approach to road safety in Greater London. In the London area, road safety is directly ensured by TfL if the road in question is part of the TfL road network and by the boroughs and the City of London for roads on their territories. TfL developed a global road safety strategy for the London area, based on the Swedish model of Vision Zero, giving local authorities guidance on road safety best practice and specifying conditions and actions for an effective partnership of TfL, the boroughs and the City of London, and the national government to accomplish relevant policies. Vision Zero emphasises preventive measures that promote safe speeds, street design, vehicles and behaviours on roads, as well as measures that reduce the severity of injuries post collision.

Notes

1 Where a data gap persists, the ITF undertakes a simple interpolation. Such interpolations are essential to support the computation of a five year average denominator (e.g. population, traffic, trips), as survey data can be missing between survey years.

2 A functional urban area consists of a city plus its commuting zone, according to the definition jointly adopted by the OECD and the European Commission (OECD, 2012). The term was formerly LUZ (larger urban zone). FUA perimeters change over time. The perimeters used in this report were defined by Eurostat (2015) as part of the Urban Audit 2011-2014. Casualty figures at FUA level were taken from CARE, a database managed by the European Commission's Directorate General for Mobility and Transport (DG MOVE). In countries recording accurate spatial information for all crashes, DG MOVE has matched crashes to the municipalities making up each FUA. This was not possible in all countries, but it enabled analysis of casualty figures in 41 FUAs.

3 The analysis relies on mortality figures, computed on daytime population, collected in the eight countries where such information was available for two or more urban areas. The analysis relies on both administrative and functional urban areas. A mathematical model (Poisson GLM) was developed in the R statistical package which controls for the differences in risk between countries and is suited to the modelling of count data.

4 Elasticity is a concept used in economics to measure a variable's sensitivity to change in another variable. It can be estimated from empirical data by a linear regression equation where both the dependent variable and the independent variable are in natural logs.

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Annex A: Estimation of trips and distances travelled in cities

In the Safer City Streets database, a trip is defined as a one-way journey with no stops, using one or several modes. When a trip involves several modes, that used for the longest distance is considered the main mode. Since some trips' traces are partly outside a given area, by convention, the number of trips in that area is the number originating inside the area.

Some information is lost when a trip is reduced to its main mode and its point of origin. Walking stages that are part of a trip involving other modes are notoriously under-represented. Collection of travel distances, on the other hand, does not require such simplification and can offer a more accurate description of how people travel. In the Safer City Streets database, travel distances are measured in kilometres, along the actual network, rather than a straight line between origin and destination.

In most cities, trips and distances are derived from *household travel surveys.* For interpretation of the figures presented in this report, and to guide cities in improving their statistical methods, it is important to be transparent and report on the weaknesses of current travel surveys as they:

- do not capture the activity of people who live outside the survey area but nonetheless travel inside this area. In the short term, the ITF applies correction factors. In the longer term, cities are invited to enlarge the survey area or produce their own estimates
- do not record the activity of professional drivers, such as couriers. Solutions to this problem are yet to be developed and harmonised
- are often scheduled at five or ten year intervals, providing no information in between. In response, the ITF interpolates mobility figures. It would be preferable if travel surveys were conducted every year. Sample size can be adjusted to control survey cost.
- are limited to one season and exclude weekends whereas crashes happen year round, so a 365-day exposure figure needs to be estimated. In the short term, the ITF applies correction factors. In the longer term, cities are invited to reconsider the survey scope. Alternatively, cities can produce their own estimates of 365-day mobility, bearing in mind the very different seasonality patterns affecting different modes.

As an alternative or a complement to travel surveys, many cities use *traffic counts* and traffic models to estimate distances and trips travelled within their boundaries. In London, pedal cycle traffic is estimated and monitored in over 1 000 randomised count locations, distributed across all street types, including car-free cycle routes (TfL, 2017). Technology such as computer vision will make such counts cheaper in the future. Nevertheless, it is important to report on weaknesses frequently associated with traffic counts in cities:

- Cities often rely on a set of count locations that is too small to derive an estimate of *total* traffic. This is frequently observed with pedestrian and cycle counts. Confronted with this problem, cities often develop an index from a small sample of counts, so as to monitor changes in traffic over time. Nevertheless, focussing on changes rather than absolute values doesn't eliminate the risk of misinterpreting the data. There is still a need to adopt robust statistical techniques.
- Where count locations are not randomised, several biases can affect the results. Only limited confidence can be put on aggregate figures in such cases

- Traffic counts and models are often limited to motor vehicles, during the weekday peak hour.

The Safer City Streets network is a place where cities can share best practice with the travel surveys and traffic counts, so this information can be used to compute road safety indicators.

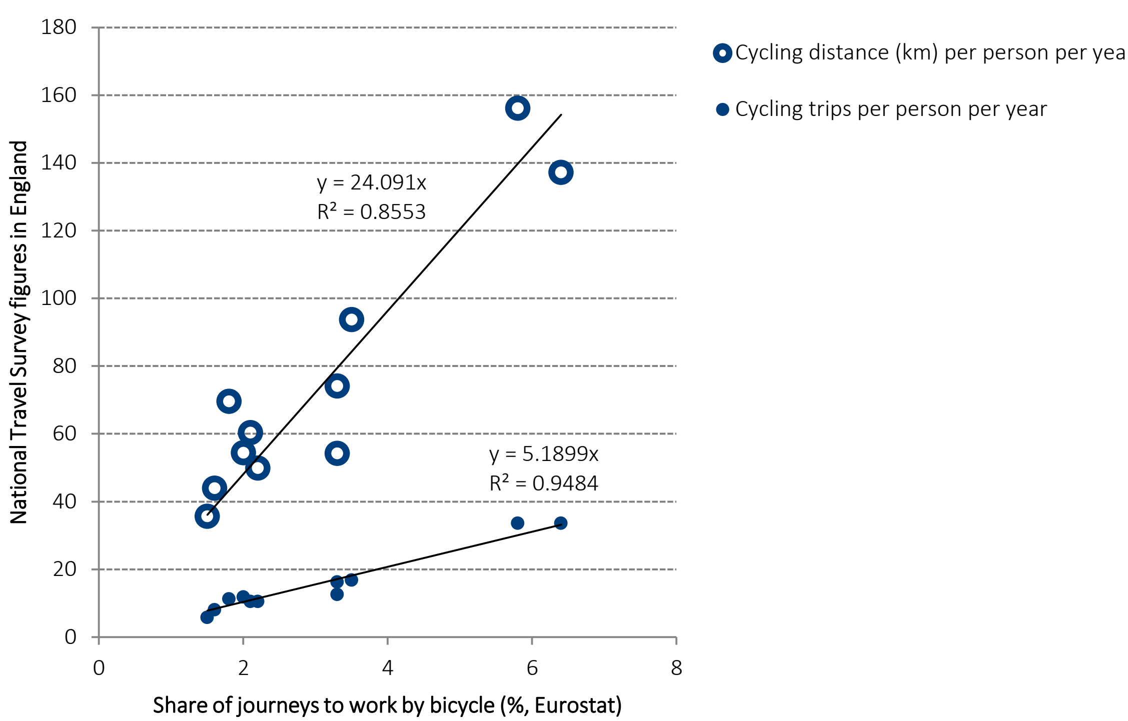
It must be noted that counts alone do not allow demographic breakdown of mobility statistics, and travel surveys alone do not allow disaggregation of mobility by street type. That is why counts and travel surveys are considered complementary data sources. For more on the collection of trips and distance data, see Santacreu (2018a, pp. 14-15) and COWI (2017).

Annex B: Estimation of trips and distances travelled in functional urban areas

The boundaries of functional urban areas (FUAs) rarely match those of a metropolitan administration. For this reason FUA statistics typically rely on national or European-led surveys. Eurostat provides a set of modal shares in journeys that work for some FUAs. This information was missing for Italian FUAs, so the ITF computed it using commuter matrices derived from population census data provided by the national statistical office, ISTAT.

Modal shares on journeys to work are not the most useful mobility figures for use in road safety indicators. Hence using travel survey data, where available, was preferred. This was possible for 11 FUAs in England as the UK Department of Transport computes trips and travel distance statistics. The cycling statistics in 15 other FUAs was estimated on the basis of correlations observed in England between cycling's modal share and cycling trips and distance statistics. Correlations were not robust enough in other modes to estimate trip numbers and travel distances.

Figure B.1. Correlation between cycling trips, distances and mode shares in functional urban areas
(in England)



Notes: data sources include Eurostat Urban Audit Database (item TT1007V) averaged over 2010-2014 and UK Department for Transport's National Travel Survey, averaged over 2009-2015

Annex C: List of cities involved in analysis

Table C.1. Population and density statistics, 2015

Country	Code	City	Land area (km^2)	Population	Population density ($/km^2$)
Argentina	ARG01	Buenos Aires	203	3 044 000	15 000
Australia	AUS02	Melbourne	8 825	4 282 000	490
Austria	AUT61	Vienna FUA	9 191	2 390 000	260
Austria	AUT63	Linz FUA	3 516	558 000	160
Austria	AUT62	Graz FUA	3 071	413 000	130
Belgium	BEL01	Brussels (a)	161	1 150 000	7 140
Brazil	BRA03	Fortaleza	313	2 538 000	8 110
Canada	CAN01	Montreal (b)	365	1 961 000	5 370
Canada	CAN03	Calgary	825	1 159 000	1 400
Canada	CAN04	Edmonton	685	858 000	1 250
Canada	CAN02	Vancouver	115	650 000	5 650
Colombia	COL01	Bogotá D.C.	1 587	7 674 000	4 840
Czech Republic	CZE61	Praha FUA	6 963	2 172 000	310
Czech Republic	CZE63	Ostrava FUA	3 870	1 132 000	290
Czech Republic	CZE62	Brno FUA	3 292	782 000	240
Denmark	DNK01	Copenhagen	86	560 000	6 510
Finland	FIN61	Helsinki FUA	3 795	1 367 000	360
France	FRA02	Paris area (c)	762	6 724 000	8 820
France	FRA01	Paris City	105	2 236 000	21 300
Germany	DEU01	Berlin	892	3 473 000	3 890
Ireland	IRL61	Dublin FUA	6 964	1 794 000	260
Ireland	IRL01	Dublin City	115	539 000	4 690
Italy	ITA61	Roma FUA	5 753	4 198 000	730
Italy	ITA62	Milano FUA	2 637	4 182 000	1 590
Italy	ITA63	Napoli FUA	1 555	3 570 000	2 300
Italy	ITA01	Rome	1 285	2 771 000	2 160
Italy	ITA64	Torino FUA	1 781	1 785 000	1 000
Italy	ITA02	Milan	182	1 355 000	7 450
Italy	ITA65	Palermo FUA	1 371	982 000	720
Italy	ITA69	Bologna FUA	2 039	763 000	370
Italy	ITA67	Firenze FUA	1 739	749 000	430
Italy	ITA66	Genova FUA	1 115	724 000	650
Italy	ITA70	Catania FUA	611	632 000	1 030
Italy	ITA68	Bari FUA	757	583 000	770
Italy	ITA71	Venezia FUA	639	499 000	780
Latvia	LVA01	Riga	304	689 000	2 270
Mexico	MEX01	Mexico City	1 485	8 721 000	5 870
Mexico	MEX03	Guadalajara	151	1 460 000	9 670
Netherlands	NLD03	The Hague	80	506 000	6 330
New Zealand	NZL01	Auckland (d)	4 894	1 505 000	310
Norway	NOR61	Oslo FUA	7 378	1 268 000	170
Poland	POL01	Warsaw	517	1 733 000	3 350
Portugal	PRT61	Lisbon FUA	3 912	2 816 000	720

Country	Code	City	Land area (km²)	Population	Population density (/km²)
Portugal	PRT62	Porto FUA	954	1 302 000	1 360
Portugal	PRT01	Lisbon	84	523 000	6 230
Serbia	SRB01	Belgrade District (e)	3 232	1 668 000	520
Slovenia	SVN61	Ljubljana FUA	2 555	537 000	210
Spain	ESP02	Madrid	608	3 203 000	5 270
Spain	ESP01	Barcelona	102	1 611 000	15 790
Sweden	SWE61	Stockholm FUA	7 047	2 073 000	290
Sweden	SWE62	Göteborg FUA	4 230	942 000	220
Sweden	SWE01	Stockholm	187	896 000	4 790
Sweden	SWE63	Malmö FUA	1 844	613 000	330
Switzerland	CHE61	Zürich FUA	1 089	1 207 000	1 110
Switzerland	CHE01	Zürich	88	396 000	4 500
United Kingdom	GBR61	London FUA	8 000	12 207 000	1 530
United Kingdom	GBR02	Greater London (f)	1 572	8 428 000	5 360
United Kingdom	GBR01	Inner London (g)	319	3 346 000	10 490
United Kingdom	GBR62	Birmingham FUA	2 068	2 873 000	1 390
United Kingdom	GBR68	Manchester FUA	1 810	2 783 000	1 540
United Kingdom	GBR64	Glasgow FUA	3 357	1 787 000	530
United Kingdom	GBR66	Liverpool FUA	722	1 508 000	2 090
United Kingdom	GBR63	Leeds FUA	1 488	1 166 000	780
United Kingdom	GBR73	Newcastle FUA	5 412	1 147 000	210
United Kingdom	GBR70	Sheffield FUA	927	911 000	980
United Kingdom	GBR71	Bristol FUA	981	900 000	920
United Kingdom	GBR69	Cardiff FUA	1 171	888 000	760
United Kingdom	GBR89	Nottingham FUA	900	875 000	970
United Kingdom	GBR74	Leicester FUA	1 392	840 000	600
United Kingdom	GBR67	Edinburgh FUA	1 720	839 000	490
United Kingdom	GBR83	Portsmouth FUA	196	522 000	2 660
The United States	USA01	New York City	792	8 406 000	10 610

Notes: (a) Brussels Capital Region, composed of 19 municipalities. (b) Urban agglomeration of Montreal, also known as Montreal Island, 16 municipalities. (c) City of Paris and three surrounding administrative units: Hauts-de-Seine, Seine St-Denis and Val de Marne. (d) Auckland council, amalgamated council since 2010. (e) Belgrade District, also called Belgrade City or Belgrade, 17 municipalities. (f) Greater London, also known as London, 33 local government districts. (g) Inner London in its statutory definition is made up of 13 local government districts.

Sources: FUA land area derived from Eurostat (2015), Urban Audit FUA 2011-2014 geography shapefile; FUA population data are from Eurostat (2010-2014 average).

International Transport Forum

Road Safety in European Cities

This reports benchmarks road safety performance for 72 urban areas, mostly in Europe, and illustrates governance solutions to improve urban road safety with case studies conducted in Lisbon (Portugal) and Riga (Latvia). The report proposes new road safety indicators to assess the level of risk for each mode of transport. It finds that a modal shift away from private motor vehicles could significantly enhance road safety in dense urban areas and deliver public health benefits associated with increased physical activity and improved air quality.

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