TfL Bus Safety Innovation Challenge

TfL's Casualty Challenge

April 2019

Introduction

In his Transport Strategy[1], the Mayor of London has made clear that serious injuries and loss of life on London's roads are neither acceptable nor inevitable. Transport for London has now adopted Vision Zero for London, with a target of zero deaths or serious injuries on London's roads and public transport network by 2041.

Bus Operations has a key part to play in achieving Vision Zero, and has its own ambitious target of nobody killed on or by a London bus by 2030. In October 2018 we launched the Bus Safety Standard[2], setting out a range of safety features which will become requirements on all London buses.

These measures will help reduce the number of casualties, and the severity of their injuries, but we know we need to do more to achieve our Vision Zero targets.

Specifically, we need to reduce injuries to the two main groups of casualties in incidents involving London buses: vulnerable road users and bus passengers. Extensive research has been conducted into how and why these groups are injured and killed. This document outlines the key sections of the evidence base for the Bus Safety Standard; as such, some of the issues covered are addressed by features within the Standard.

This document should therefore be read in conjunction with the Bus Safety Standard Roadmap[3]. If you have developed a product or bus feature that would address any of the issues in this document, has **not** already been trialled on a London bus, and is **not** in the roadmap, we look forward to hearing about it through the Bus Safety Innovation Challenge.

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[1] https://tfl.gov.uk/corporate/about-tfl/the-mayors-transport-strategy
[2] http://content.tfl.gov.uk/bus-safety-standard-executive-summary.pdf
[3] http://content.tfl.gov.uk/bus-safety-road-map-for-new-build-buses.pdf

Overview of historical casualty data

The high-level matrix in Table 1 categorises the types of collisions and casualties in incidents involving buses in London. This is based on past data for London (2006-2015), derived from the national accident database from the UK Department for Transport.

Table 1: Matrix of historical data by casualty and collision type.

Casualty type	Collision type	Fatal	Serious	Slight	KSI[4]	Total
Bus Occupants	**Total**	**2.2%**	**18.7%**	**18.4%**	**20.9%**	**39.3%**
	Injured in non-collision incidents - Standing passenger	1.4%	8.2%	7.6%	9.5%	17.1%
	Injured in non-collision incidents - Seated passenger	0.2%	3.2%	4.3%	3.4%	7.7%
	Injured in non-collision incidents - Boarding/Alighting/Other	0.5%	4.0%	1.9%	4.5%	6.4%
	Injured in collision incidents	0.2%	3.3%	4.6%	3.5%	8.1%
Pedestrians	**Total**	**18.3%**	**15.6%**	**4.4%**	**33.9%**	**38.3%**
	Crossing in front of a bus travelling on the main road	8.0%	8.1%	1.7%	16.1%	17.8%
	Injured by a bus turning left or right	4.1%	1.5%	0.4%	5.6%	6.0%
	Injured by a bus moving off from rest	2.4%	1.8%	0.6%	4.1%	4.8%
	Injured in other collisions with a bus	3.9%	4.2%	1.7%	8.1%	9.8%
Car Occupants	**Total**	**4.4%**	**3.1%**	**3.3%**	**7.5%**	**10.9%**
	Injured in head on collisions with a bus	2.0%	0.9%	0.3%	2.9%	3.2%
	Injured when front of bus hits rear of car	0.5%	0.3%	0.8%	0.9%	1.7%
	Injured in other collisions with a bus	1.9%	1.9%	2.2%	3.8%	6.0%
Cyclists	**Total**	**1.4%**	**3.4%**	**1.6%**	**4.7%**	**6.3%**
	Injured in collision with a bus travelling along the road	0.7%	1.1%	0.6%	1.8%	2.4%
	Injured in a collision with a bus turning left or right	0.7%	0.7%	0.3%	1.4%	1.7%
	Injured in other collisions with a bus	0.0%	1.5%	0.8%	1.5%	2.3%
Motorcyclists	**Total**	**1.2%**	**1.6%**	**0.8%**	**2.8%**	**3.6%**
	Injured in collision with a bus travelling along the road	0.8%	0.6%	0.2%	1.5%	1.7%
	Injured in a collision with a bus turning left or right	0.2%	0.5%	0.2%	0.7%	0.9%
	Injured in other collisions with a bus	0.2%	0.5%	0.3%	0.7%	1.0%
Other	**Total**	**0.5%**	**0.6%**	**0.5%**	**1.1%**	**1.6%**
Total		28.0%	42.9%	29.1%	70.9%	100.0%

[4] KSI = Killed and Seriously Injured

As the table shows, the primary casualty groups are **bus occupants** and – when grouped together – **Vulnerable Road Users (VRUs – pedestrians, cyclists and motorcyclists)**.

Vulnerable Road Users (VRUs)

In 2017, just under half of those killed or seriously injured (KSI) as a result of collisions with London buses were VRUs; pedestrians, pedal cyclists and motorcyclists. The casualty types are summarised in Figure 1:

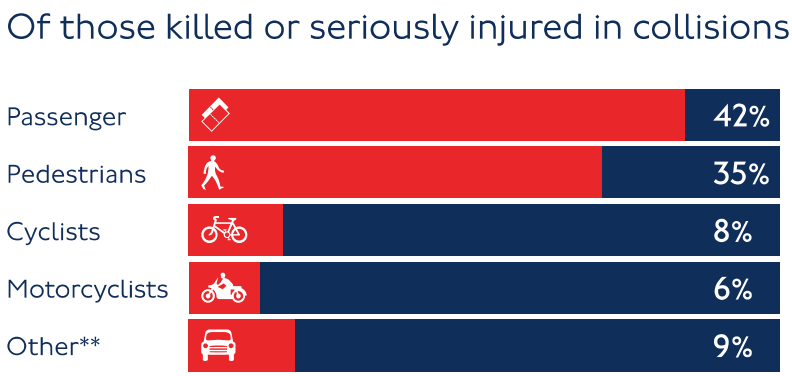


Figure 1: Killed and Seriously Injured casualties by type.

Figure 2 shows the risk of different groups of VRUs being involved in KSI collisions with different kinds of motor vehicles. Relative to their share of traffic, buses are 4.5 times more likely to be involved in a KSI collision with a pedestrian; this figure is 1.75 times for cyclists and 1.85 times for motorcyclists.

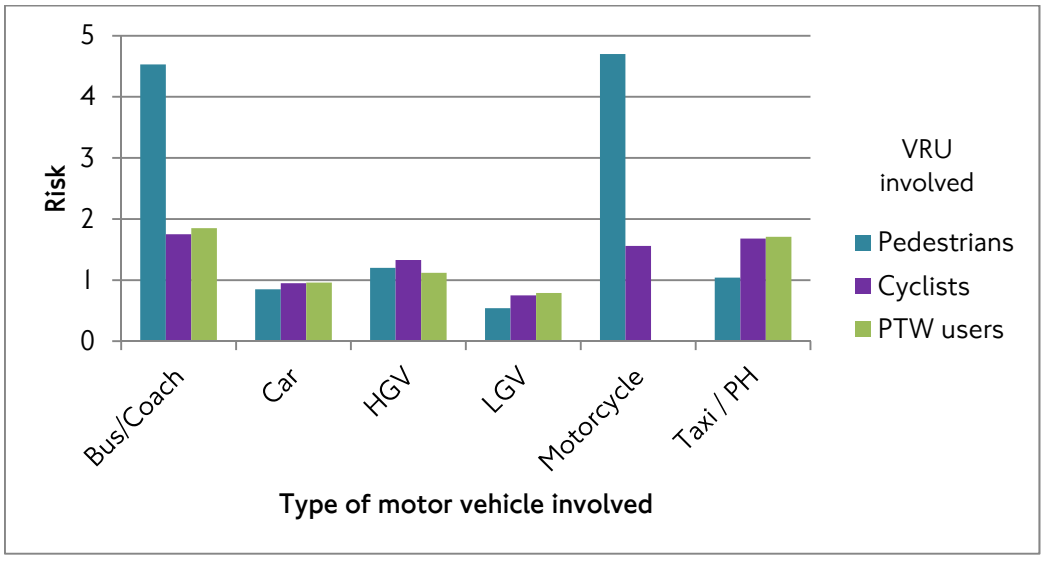


Figure 2: Risk of motor vehicles being involved in KSI collisions with VRUs relative to their share of traffic.

Research has shown that the nature and causes of these collisions vary for the different groups of VRUs.

Pedestrians are typically hit by the front of the bus when it is moving slowly or going ahead. These collisions most commonly occur when the pedestrian is crossing from the nearside and not using a pedestrian crossing.

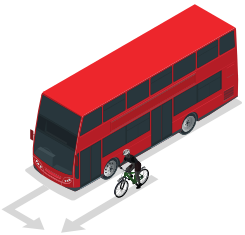
CCTV analysis of bus collisions with pedestrians has shown that in 87% of cases the 'time to collision' is under 2 seconds, and under 1 second in 67% of cases. This is the period between the pedestrian first becoming recognisable as an imminent collision risk (i.e. the moment they turn to start crossing or emerge from behind an obstruction) and impact. A driver exhibiting a normal reaction time of 0.75 to 1.5 seconds therefore has very little opportunity to avoid a collision.

In addition, vehicle-related factors include blind spots preventing the driver seeing pedestrians, especially when pulling away from bus stops, and pedestrians being hit by wing mirrors.

Environmental factors include a lack of physical separation between buses and pavements, a lack of safe crossing facilities for pedestrians, and the bus driver's vision being obscured by the location of parked vehicles and other buses at bus stops.

The behaviour of both pedestrians and bus drivers also contributes to these collisions. Pedestrians may cause a collision if they are distracted, not conspicuous in the dark or poor weather, or not using crossings correctly (e.g. not waiting for signals).

Driver behaviour such as speeding, not looking properly, passing too close to pedestrians, or failing to stop at crossings can also be a contributory factor.

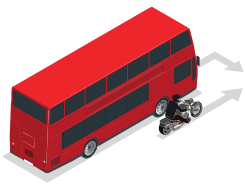


Pedal cyclists are most frequently hit by the front of the bus. Collisions can also occur when the bus is turning.

A common cause for this type of collision is that it is difficult for bus drivers to detect cyclists, particularly when pulling away from bus stops.

Environmental factors, such as narrow lanes which make it difficult to pass cyclists, can also be contributory factors. Collisions with cyclists are most likely at uncontrolled junctions and points where cycle lanes join main roads.

As with collisions with pedestrians, unsafe speeds and driver behaviour can present a risk to cyclists. Cyclists' behaviour can also lead to collisions, for example swerving in front of the bus, poor judgement and poor conspicuity in the dark or in bad weather.



Motorcyclists are most frequently injured in collisions with the front of the bus.

As with pedestrians and pedal cyclists, vehicle blind spots can make it difficult for bus drivers to detect motorcyclists, particularly when pulling away from bus stops.

In addition to the driver behavioural factors in the above sections, the behaviour and driving style of the motorcyclist can also cause collisions. For example, sudden braking, following too closely, inexperience, loss of control and lack of conspicuity were all noted as factors in previous incidents.

Bus Passengers

Alongside VRUs, the other main group within the casualty data is bus passengers.

In collisions involving buses, the majority (64%) of casualties are bus passengers. However, bus operator data also indicates that 76% of all injuries sustained by bus passengers happen without the bus being involved in a collision.

In total, there were 3,074 slips, trips and falls on board London buses in 2017. Figure 3 shows how these injuries occurred:

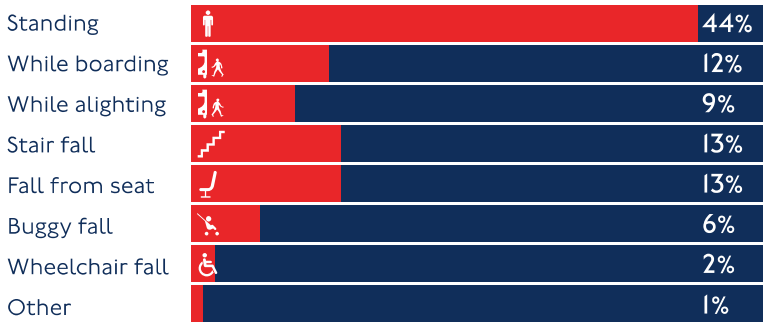


Figure 3: Causes of bus passenger injuries, 2017.

As with collisions with VRUs, injuries to bus passengers may be caused or exacerbated by driver behaviour, passenger behaviour, or features inside the vehicle.

The driver's driving style is often a factor, for example heavy/sudden acceleration or braking, pulling away whilst passengers are still moving towards seats or handrails, or erratic driving caused by distractions.

Injuries are more likely to occur if passengers are intoxicated, distracting drivers, or moving inside the bus – particularly up/down the stairs – whilst it is also moving.

Vehicle-related factors are also important for bus passengers. When passengers are moved from their seat or standing position, either as a result of a collision or harsh braking/acceleration, they may be injured by colliding with an interior feature of the bus.

In injuries to **standing passengers**, the parts of the bus hit most frequently are the floor, vertical handrails (grab poles), and partition panels. The head and chest are the most commonly impacted parts of the body.

Many who fall from a standing position were transitioning into or out of a seat, commonly elderly passengers who are generally less stable. Where there are steps to reach the seats, this risk is increased.

Other common types of injuries include passengers being struck or trapped by the doors, falls associated with the stairs, and slips, trips and falls due to the floor material.

For **seated passengers**, the parts of the bus hit most frequently are the vertical handrails, followed by the seat in front. Particular issues identified in analysis of previous incidents include buggies tipping over when positioned sideways to the direction of travel, and a lack of restraint for passengers seated in the middle rear seat.

Future casualty estimates

With the implementation of the new Bus Safety Standard (BSS) requirements into the Bus Vehicle Specification that is used in the contracting of routes, the BSS is expected to have an influence in reducing casualties. Figure 4 illustrates the modelling of casualty numbers, converted into societal costs relating to casualty injury severities, to estimate the predicted net effect of the BSS.

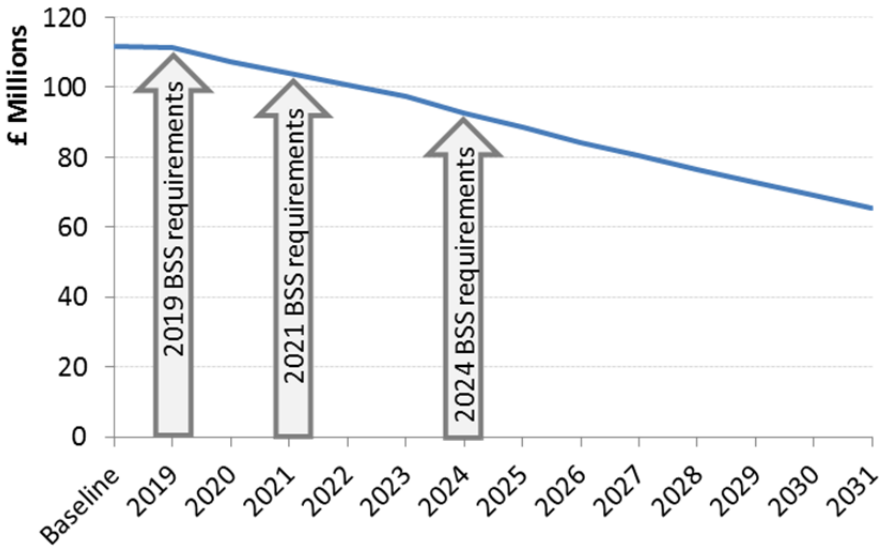


Figure 4: Estimated remaining monetised societal casualty costs after the BSS implementation (all casualty types and severities).

The BSS is currently addressing the safety measures in the graphic in Figure 5. These were selected based on historical data (as described previously), which means most of the measures are aimed at avoiding, or mitigating the severity of, VRU casualties and bus occupants.

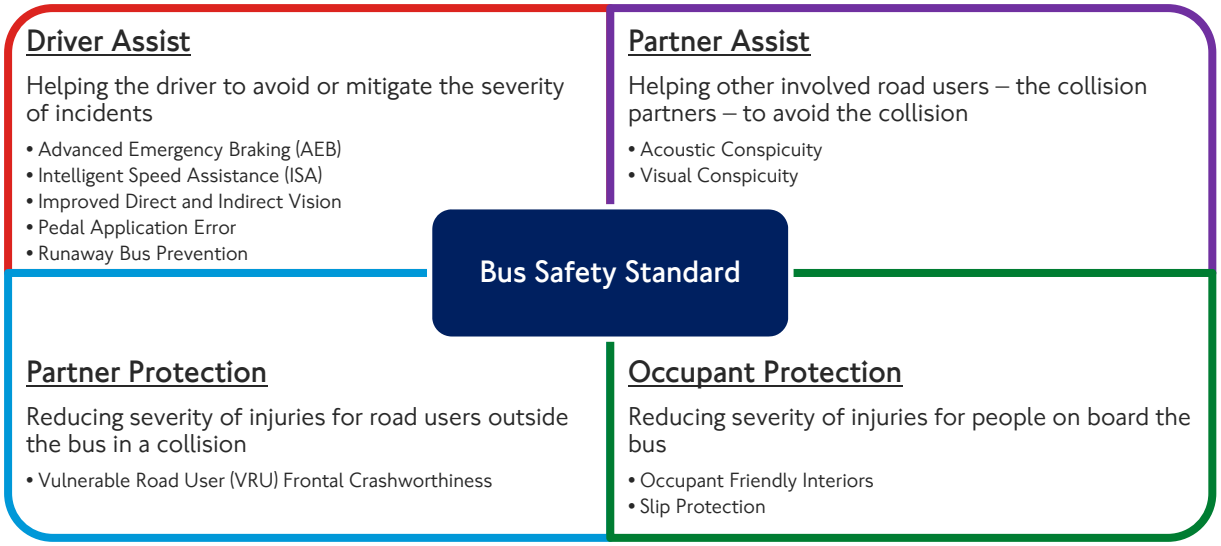


Figure 5: Summary of BSS safety measures.

Therefore, not only is the BSS estimated to reduce overall casualty numbers, but also the mix of the different types of casualties is likely to change. Because the VRU and bus occupant casualties were the focus of several requirements of the BSS, then these casualty numbers are anticipated to also reduce. However other casualty types that are not yet fully addressed by the BSS are likely to remain; and will proportionally increase in their future importance. This shift in the relative importance of these casualty types is described in Figure 6.

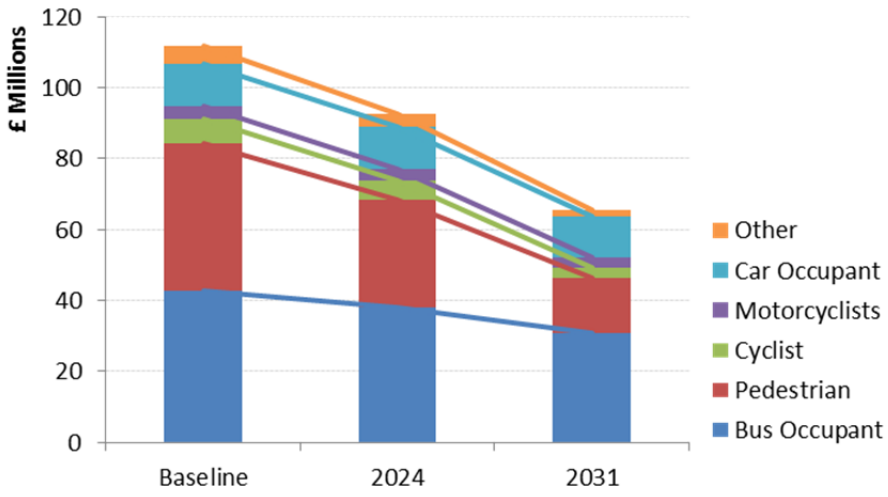


Figure 6: Estimated remaining monetised societal casualty costs after the BSS implementation (by casualty types and year).

This indicates quite clearly that:

- Casualties will reduce overall
- The main reduction will be for pedestrian casualties
- Bus occupant casualties will also be reduced by the BSS
- There will also be some reduction of cyclist casualties
- Other groups of casualties remain

When considering the future landscape of casualties caused by or on buses in 2031, the distribution of societal costs associated with each casualty type may be estimated based on the modelling, and is shown in Figure 7.

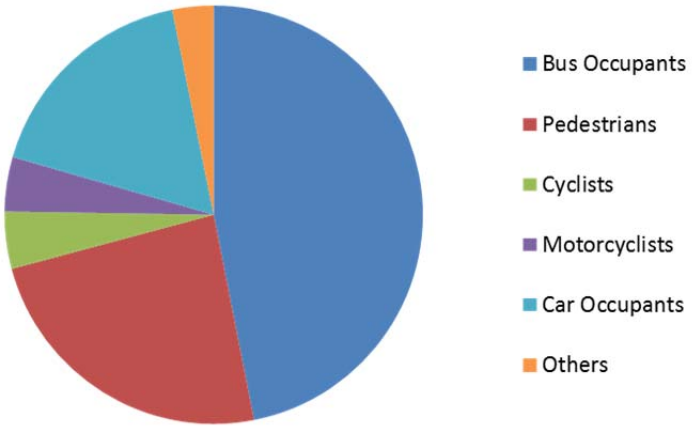


Figure 7: 2031 estimated remaining monetised societal casualty costs after the BSS implementation (all casualty types and severities).

The above is a combination of all casualty severities. But it is also useful to consider the casualty types for each injury severity level, as shown in Figure 8. The modelling estimates show that in terms of fatalities, the pedestrian group will likely remain the largest proportion, followed by car occupants. But for serious and slight injuries, the bus occupants are estimated to represent the largest group of casualties.

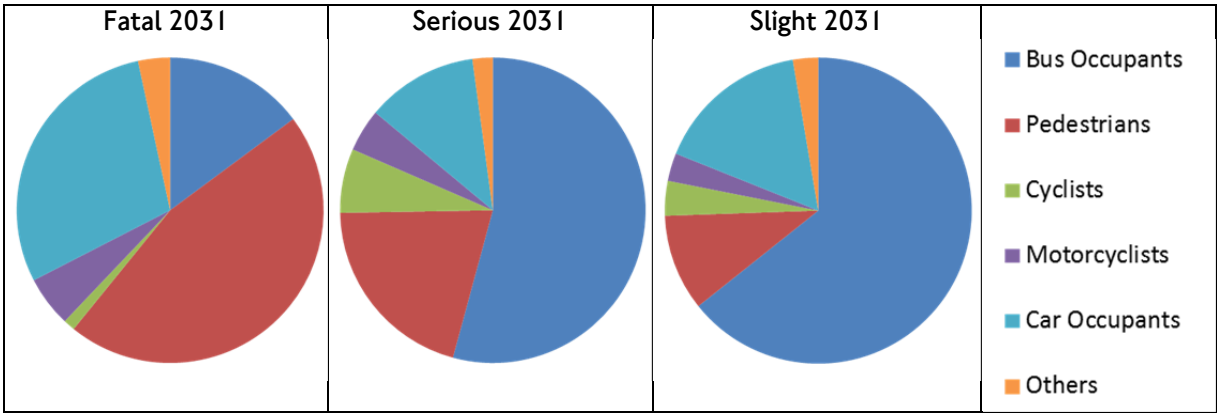


Figure 8: 2031 estimated remaining monetised societal casualty costs after the BSS implementation (all casualty types with comparison of severities).

Further Information

TfL is planning to further refine the modelling of the future casualty landscape, including greater detail of the casualty and collision types not yet addressed by the BSS. This information will be made available in due course.

Please also see https://tfl.gov.uk/cdn/static/cms/documents/analysis-of-bus-collisions-and-identification-of-countermeasures.pdf for greater details about fatality circumstances. This report analyses data from Stats19, the police fatal archive (police fatal files) the Road Accident In Depth Studies (RAIDS), and the Heavy Vehicle Crash Injury Study (HVCIS) to examine collisions involving buses. It uses the in-depth collision details to assign countermeasures that might help to avoid or mitigate the severity of each collision.