Appendix 1

AECOM

Bus Safety Standard: Report - Pedal Confusion

Transport for London

August 2022

Delivering a better world

Quality information

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Executive summary

Introduction

AECOM were commissioned to research the frequency that pedal confusion occurs and the number of incidents of pedal confusion that go unreported by drivers, if any, such as occasions when they recover before there is an incident. Additionally, AECOM held workshops and discussions with stakeholders from TfL, bus operators, Unions and drivers to evaluate opinion of six proposed solutions put forward following previous work in 2018 by TfL and the Transport Research Laboratory which were based on the recommendations from a 2011 report.

Research was completed using various methodologies

- Secondary data analysis: A literature review of published studies about pedal confusion and use of the Incident Reporting & Investigation System (IRIS) data with support from the Notification and Investigation of Major Incidents (NIMI) data.
- Primary research in three stages:
    1. An online survey for drivers and other bus operator employees to complete, with 593 drivers self-selecting to complete the survey;
    2. Group discussions with 45 drivers for additional detail about their views; and
    3. Ten workshops with a total of 86 key stakeholders and union representatives with various roles (engineering, operations, health and safety) and responsibilities (manufacturers, operators and TfL stakeholders).

Number of incidents and locations of pedal confusion

Secondary data findings using IRIS data

- 143 pedal confusion incidents reported between 2015 and 2019 an average number of 29 incidents per year. 19 of these were flagged as NIMI

Between 2015 and 2019:

- There was an average of 2.4 incidents per month;
- Tuesday saw the highest number of incidents (35) and Sunday the lowest (9); and
- The times when the highest number of incidents took place was between 15:00 and 16:00 and between 10:00 and 11:00.

Findings from the drivers online survey

- Approximately 1 in 5 drivers (22%) were unaware of pedal confusion (78% aware);
- 44% had awareness of incidents (56% unaware);
- 16% of drivers have experienced unintended acceleration at any time;
- 9% of drivers experienced unintended acceleration in the past year; and
- 1.3% of drivers experienced a collision due to unintended acceleration.

Of the 53 drivers* who experienced unintended acceleration in the past year, 85% of these experiences did not result in a collision.

***Note**: the low base of 53 drivers means statistically significant conclusions cannot be made and data should be treated with caution and considered indicative.

Locations of the 143 incidents identified in the IRIS data

- Most incidents occurred on a two-way major road, the second most on a two-way minor road. IRIS data reports often refer to the start-stop nature of the traffic;
- A third of all incidents took place as a bus is approaching either a stand, a stop or moving traffic; and
- Half the incidents did not involve a third-party vehicle

Possible causes of pedal confusion

All views provided in the survey were based on driver opinion, similarly, all views in the workshops were from the attendees own opinion and experience. A main recommendation of this report is to build the evidence to confirm whether these opinions are validated.

The main themes expressed by those who attended the workshop were:

Pedal configuration

- Pedal sizes and spacing between the pedals were referenced as possible causes. Pedal configuration on electric and hybrid vehicles and the New Routemaster bus were an example where pedal configuration may lead to pedal confusion.

Hybrid and electric buses driving style

- Drivers and workshop attendees stated a belief that the regeneration feature on hybrid and electric vehicles may confuse the driver as it provides the option for “one pedal driving” and drivers may become confused about which pedal their foot is covering, particularly as the vehicle slows down even though they are covering the accelerator pedal.

Possible driver related causes of pedal confusion

- Driver concentration;
- Passenger interaction; and
- Driver pressure to meet stand times or finish their shift (including home pressure)

Drivers’ opinions of the factors causing pedal confusion from the online survey

- The top two factors according to drivers who responded to the survey were fatigue and human error with just over half the drivers mentioning at least one of these;
- A fifth of drivers believed that driving in heavy, stop/start traffic was a contributory factor;
- Drivers who had experienced pedal confusion previously were more likely to say that pedal confusion is most likely to occur at any point in the shift compared to those who had not experienced pedal confusion (50% compared to 29%); and
- More drivers with under 5 years’ experience agree with the statement “**“I have been trained to recognise when unintended acceleration is occurring and how to respond to it”** than those who have over 5 years’ experience (55% compared to 43%). There is no significant difference in the views between those who have and have not experienced pedal confusion.

Potential solutions to pedal confusion

In the same manner as the possible causes of pedal confusion, all views expressed in the survey and workshops were opinion based and not evidence led. The six solutions[1] shown during the workshops, using previous work from TfL Human Factors and Transport Research Laboratory were:

Brake Toggling:

- Believed this would be effective during setting off manoeuvres, but as most pedal confusion incidents occur at slow speeds, this needs to be complemented by another solution(s); and
- Drivers believed that while there would be a benefit when setting off, it would add to journey time.

Improve direct / indirect vision

- The link between improving vision around the whole of the bus and pedal confusion was not obvious to workshop attendees and once explained, nearly all disagreed with the link. There was an expectation that drivers would move in their cab anyway, such as turning around to speak to passengers; and
- Drivers were as concerned with the practicialites of driving as much as the benefit as a solution, believing this would add on time.

Pedal acoustic feedback (audible cue) and Pedal light indicator (visual cue)

- The main observations for pedal acoustic feedback and pedal light indicators were very similar, it was believed that these two solutions had merit but relied on the driver to react and intepret the sound they heard or light they saw, with some feeling that in a stressful, panic situation this may not happen, or happen in time;
- There was a view that both lights and noises would be ignored based on current experience of introducing other warning lights; and
- The majority of workshop attendees believed the light was preferable to an audible cue (sound), however some attendees provided the counter argument that drivers should be encouraged to keep their eyes on the road rather than the dashboard.

Advanced Emergency Braking (AEB)

- Those attending workshops agreed this would be a long-term consideration, adding that technology would need substantial testing, particularly around sensitivity of the AEB and when it is applied, before it could be put on the buses and for drivers to be comfortable with the technology being used;
- Bus manufacturers believed there were risks, providing scenarios where drivers would need to accelerate at times, this was echoed by workshop attendees who were equally concerned about stopping distances and reaction times; and.
- Many caveated that AEB was a postive part of the solutoin but would be a contribution rather than a solution on its own.

Pedal Standardisation

- Most attendees believed this would be the most effective solution of the six solutions shown, seeing the benefit as reducing unfamiliarity as drivers change buses during a shift, ‘spare’ drivers who regularly change buses were used as an example; and

[1] Three solutions: Brake togging, direct/indirect vision and the pedal light indicator have been introduced into the 2021 Bus Safety Standard therefore some workshop attendees were already familiar.

- Engineers and Health and Safety workshops attendees both brought up the concern that if pedals are standardised the importance of right first time design, and building knowledge based on evidence that standardising pedals will have a positive impact on reducing pedal confusion is critical.

Other potential solutions

A number of other solutions were discussed, in the main there were two themes.

Interim solution similar to AEB

- Use current technology to measure the pressure applied to the accelerator by a driver at all times, should this ever be full pressure (similar to the action of stamping on the brake), override the response.
- Operations teams, Engineers and Health and Safety workshop attendees were amongst those who, independently from one another, believed this type of interim solution was worth investigating and could be implemented in the short term. Attendees in other workshops used the term “dead man’s switch” such as a cut-off switch a train has or electric milk floats.

Reducing driver pressure and fatigue

- TfL, Operator, Unions and Drivers expressed their view that drivers work under pressure or have other distractions from passengers and other road users. There was a belief that reducing pressure on drivers including time between shifts (fatigue) would reduce incidents in general, including pedal confusion.

Recommendations

There are a number of recommendations which can be grouped under the safe system pillars that TfL has adopted in their Vision Zero approach to road safety.

This report acknowledges that some of the solutions presented in the workshop have been introduced on new buses in the fleet, as per the BSS roadmap and recommends that all future incident investigations linked to possible pedal confusion to report which if any solutions were a feature on the bus and if they were not a feature for the incident investigator to provide an opinion about whether any of the solutions could have prevented the incident.

Safe behaviours

Monitor any evidence that driver movement has been a contributory factor to pedal confusion. If monitoring shows a link to pedal confusion, update driver training and education.

Review the iBus controllers’ communication procedures with drivers, and ensure drivers are receiving training for correct use of iBus foot switch.

Investigate if any solutions to driver fatigue, as provided in the fatigue report, will reduce pedal confusion incidents or has reduced incidents once implemented.

Review whether footwear has a link to pedal confusion incidents. If a link is found, consider additional testing and trials to resolve this.

Investigate if ‘spare’ drivers, who regularly change buses are more likely to be involved in pedal confusion incidents or near misses.

Safe vehicles

Explore differentials across bus make and model for pedal type, height, and spacing by conducting an audit of the current fleet.
Build a library of lessons learnt from current technology such as early warning systems.
Use learnings from AVAS to develop a sound for pedal acoustic feedback; aim to produce a multi-beneficial sound such as improving driving style.
Conduct further analysis to understand whether travelling at slow speed and/or in heavy traffic is a contributory factor and if so add further workstreams such as driver training.
Conduct further analysis to measure brake regeneration in hybrid and electric buses as a possible cause using current data and/or track tests with drivers.
Measure if the assumed difference in acceleration between electric, hybrid and diesel buses is shown in driver data and if so, whether this could have an impact for pedal confusion.
Consider building a team of experts to design, validate and test the AEB parameters and to cover training and implementation once approved.
Engage with bus manufacturers for a possible review of the International Standards Organisation (ISO) standard for pedal layout.
Build an expert working group with the remit to assess what pedal standardisation could look like with pros and cons. Use findings from the analysis of the 143 incidents suggested for further evidence.

Post collision response

Review and improve the IRIS database with more fields including one specifically for suspected pedal confusion.
Explore measuring traffic flow prior to an incident. Record the road layout, traffic flow procedures (e.g., traffic lights); number of lanes, any joining or additional lanes, bus lane available.
Introduce footwell cameras on buses supporting driver education, incident prevention and incident investigation.
Analyse pedal configuration for each of the 143 incidents for similarities and differences.
Measure if buses with brake toggling are involved in fewer incidents; include near-miss data.
Contact the International Bus Benchmarking Group (IBBG) for learnings from the international industry and if there is appetite for a forum for best practice and solutions.
Work with bus operators to build a national view of pedal confusion for the UK.
Contact other UK industries, starting with waste disposal, investigate if pedal confusion incidents occur in their industry.

1. Introduction

1.1 Background

Pedal confusion has been defined as the manoeuvre where a driver confuses the acceleration pedal with the brake pedal resulting in either sudden unintended acceleration or harsh braking.

At present the scale or nature of the problem among London bus drivers is unknown and there are concerns of under-reporting of incidents by bus drivers, particularly if the driver is able to recover in time resulting in no collision occurring.

A better understanding of the nature and extent of pedal confusion incidents occurring amongst London bus drivers is required to support the decision on the most appropriate solution(s) to mitigate the issue of pedal confusion. TfL accepts that, while mistakes must be minimised, there will always be the chance of human error and one of the priorities for TfL is to make the whole system as safe as possible so that when a road user does make a mistake this does not result in serious or fatal injury.

The information provided in this report is intended to act as part of the supporting evidence for TfL to deliver Vision Zero for London which has a goal, as set out in the Mayor's Transport Strategy, that by 2041, all deaths and serious injuries will be eliminated from London's transport network.

1.2 Objectives

The primary objective of the research was to better understand pedal confusion, specifically:

- The nature and extent of pedal confusion incidents occurring amongst London bus drivers;
- Learn of any key causes and patterns which may increase the possibility of pedal confusion, and specifically if they are related to the driver, vehicle and / or environmental circumstance;
- Whether pedal confusion is attributed to unintended acceleration only or if harsh braking should be considered as well;
- Whether there are any environmental characteristics which contribute to pedal confusion incidents;
- To assess driver and stakeholder views of six proposed solutions* and their ability to reduce the number of any pedal confusion incidents; and
- To learn of any other suggestions of solutions for future thinking.

*The six proposed solutions were established following initial research and recommendations completed by TfL Human Factors in 2011 and an additional report with recommended safety measures evaluated by the Transport Research Laboratory (TRL) in 2018 [2].

One of the challenges to overcome is any fear of reprisal drivers are likely to have or the human trait to avoid admitting they have done something "wrong". AECOM reassured drivers about treating their data in confidence through the UK GDPR and further by reassuring anonymity in the reporting through the Market Research Society Code of Conduct, of which AECOM are Company Partners.

[2] Identifying solutions to pedal confusion in buses 2011: https://content.tfl.gov.uk/solutions-to-pedal-confusion.pdf
Pedal Application Error Prevention and Recovery 2018: https://content.tfl.gov.uk/pedal-application-error.pdf

1.3 Methodology

There were various types of data already available about the topic of pedal confusion, and due to a diverse nature of the respondents the following three different methodologies were used.

1.3.1 Method 1: Secondary data review

An analysis of the Incident Reporting & Investigation System (IRIS) and the Notification and Investigation of Major Incidents (NIMI) databases was undertaken to determine the number of incidents and the patterns in the occurrences of pedal confusion incidents, if any.

The Incident Reporting & Investigation System (IRIS) (2015-2019)

This database covers a range of parameters for road safety data relating to information recorded by bus operators and contains a detailed account of the incident, including a record of the primary and secondary types of incident and a description of the incident. The incident description is a key determinant of whether an incident was due to pedal confusion.

The Notification and Investigation of Major Incidents (NIMI) database (2018-2021)

A record of major incidents resulting from pedal confusion was provided by TfL. This database is separate to the NIMI cases identified within the IRIS database. The database covers the period from 2018 to 2021 and includes 18 records (two of which are ongoing investigations). NIMI data has recently been supported in some cases by the provision of footwell cameras, although reviewing this data was not part of this research as incidents had already been investigated.

Literature review

AECOM sourced data sets and reports and conducted a literature review, a list of the titles reviewed is shown in Appendix A.

STATS19 data

STATS19 data is published annually by the Department for Transport and this holds a data set of factors contributing to accidents recorded by police officers. STAT19 data was analysed as part of our data review. We found that while there are multiple factors that could potentially relate to pedal confusion incidents as there are no contributory factors that specifically reference it directly. The nearest contributory factors recorded are:

- 401 – Junction overshoot;
- 402 – Junction restart (moving off at junction);
- 509 – Distraction in vehicle;
- 605 – Learner or inexperienced driver / rider; and
- 607 – Unfamiliar with model of vehicle

In discussion with TfL, it was agreed that STATS19 data would not be included in the report.

1.3.2 Method 2: Driver survey (Online questionnaire)

Drivers were invited to take part in an online survey which took approximately 10 minutes to complete. The drivers who participated in the survey work for various operators, namely:

- Abellio;
- Arriva;
- HCT;

- Metroline;
- Stagecoach; and
- Tower Transit;

All drivers were eligible to take part and the survey was operated online, therefore drivers could select whether they wanted to complete the survey and could participate at any time, 24 hours a day, 7 days a week.

There were 593 completed surveys and while this number of responses is suitable for analysis with a level of confidence at the 95% level of +/- 4%, the responses should not be considered representative of drivers as the survey was self-select and the profile of drivers may skew to those with more experience, as described in section 2.

To inform and encourage participation:

- Each operator communicated details of the survey and how to provide feedback using a prepared information sheet, an example of this is in Appendix B;
- Drivers were informed of the survey using the operators' internal communication system and a survey link provided. A QR code was also included as an easy to use, alternative method for drivers to access the survey; and
- Drivers were incentivised to participate with a prize draw for each operator with one winner (£100 voucher) and two runners-up (£50 voucher each).

It was explained to all potential respondents that:

1. Data was being collected under the UK GDPR; and
2. AECOM are accredited as a Market Research Society (MRS) Company Partner and collected data under the MRS Code of Conduct, with a summary of the key points about anonymity and confidentiality explained to drivers.

AECOM interviewers attended 32 of the busiest garages, split by operator, to further communicate the importance to AECOM, TfL and bus operators about confidentiality, anonymity and a chance to respond freely without fear of retribution.

While at the garages, AECOM interviewers carried a tablet and invited anybody who was available to complete the survey at that time to do so. The survey on the tablet was identical to the online survey and the driver was handed the tablet to ensure this continued to be a self-complete survey, i.e. the interviewer did not read out the questions and importantly the driver did not need to vocalise their response on a sensitive subject.

1.3.2.1 Questionnaire

A copy of the questionnaire can be found in Appendix C, questions included:

- Experience as a driver;
- Opinions on frequency of pedal confusion including:
    - Personal experience
    - Knowledge of other drivers' experience
- Potential causes of pedal confusion; and
- Potential solutions to pedal confusion.

1.3.3 Method 3: Workshops

1.3.3.1 Driver only workshops

At the end of the online survey, drivers were offered an opportunity to provide their details if they wanted to participate in workshops. Those who were undecided at the time, or only wanted to participate in the workshops and not the survey, were offered the chance to leave their details using a separate link specifically for the discussions.

Drivers were invited to attend workshops at various times of the day to support the flexibility needed due to their shifts. To ensure shift patterns were not disrupted, AECOM arranged for workshops to take place outside of the drivers' working hours.

Workshops were held at either 4pm, 5pm, 6pm or 7pm with between two and four drivers attending each one. Drivers working later shifts were offered a chance to hold discussions at either 11am, 12pm or 1pm, to suit their shift pattern.

Each workshop lasted between 60 and 90 minutes, depending on the number of attendees. Each attendee received a £50 voucher to reflect time spent outside of working hours.

1.3.3.2 Stakeholder workshops

Stakeholders with a specific subject interest were invited to participate in one of ten workshops, each one lasting between 90 minutes and two hours. Those attending were from various bus operators, TfL and bus manufacturers. The workshop types based on roles and responsibilities are shown in Table 1.1. A total of 45 drivers and 86 stakeholders participated in the workshops.

Table 1.1 Stakeholder workshops and roles of attendees

Workshop	Representing	Roles and responsibilities of attendees
1	Bus manufacturers	Bus manufacturers
2	TfL	Health and safety experts
3	TfL	Operations experts
4	Bus operators	Health and safety experts
5	Bus operators	Operations experts
6	Bus operators	Incident investigators
7	Bus operators	Driver trainers
8	Union representatives	Bus operator staff nominated representatives
9	Union officials	Union officials
10	TfL and bus operators (combined group)	Engineers

The discussion guide for both driver and stakeholder workshops can be found in Appendix D.

1.4 Project timings

The project ran from July to October 2021.

The start date for the online survey varied by bus operator, with three weeks allowed for employees of the final operator to participate. Operators who started participating earlier, sent

reminder communications to drivers as well as confirmation of the final date they could respond. The timings by methodology are shown in Table 1.2.

Table 1.2 Project timings by methodology

Methodology	Start date	End date
Secondary data analysis	12 July 2021	22 October 2021
Online survey	12 July 2021	13 September 2021
Workshops	7 September 2021	19 October 2021

1.5 Data analysis and reporting

This report highlights the key findings from each data source, namely:

1. Secondary data;
2. Online quantitative survey; and
3. Workshops.

Where appropriate any statistically significant difference in response to the online survey have been highlighted although in general there were very few statistically significant differences. The significant differences were either based on the years' experience of a driver or whether a driver had experienced pedal confusion themselves.

To enable the report to be easily read and understood, all reported figures have been rounded to the nearest number or percentage. The rounding effect may cause some charts to sum 99 or 101 percent. If respondents could give more than one answer to a question, then the chart will sum to over 100%.

NOTE OF CAUTION: The online survey was using self-selection by drivers, therefore while the number of responses is suitable for analysis it should not be considered representative of bus drivers.

1.6 Definition of pedal confusion

As a point of clarity, all respondents, whether via the online survey or in the workshops were provided with definitions of pedal confusion.

Online survey definition of pedal confusion

> Pedal confusion is defined as an occurrence of a driver accidentally selecting the brake pedal instead of the accelerator pedal or the other way around. This causes either sudden unintended acceleration or harsh braking. This may lead to incidents such as a collision outside the vehicle, passengers being jolted inside the vehicle or may have no impact at all such as a near miss as the driver successfully recovered the situation.

The definition for the online survey was more detailed than the workshop definition. The detail in the online survey was included to ensure drivers considered all aspects of incidents as those responding did not have an opportunity to clarify, and the definition included softer words such as "accidentally".

Workshop definition of pedal confusion

> Pedal confusion can be defined as the manoeuvre of a driver confusing the brake pedal and the accelerator pedal thus causing an incident of sudden unintended acceleration or harsh braking of their vehicle

Those who attended the workshops were asked for feedback about the definition and while there was agreement about the definition there was also a view that:

1. The word manoeuvre should be replaced by action; and
2. Pedal confusion was associated with unintended acceleration and not harsh braking and many attendees did not agree that harsh braking should be part of the definition.

Confirmed definition of pedal confusion

The agreed definition amongst workshop attendees is shown below, with the change of the word “manoeuvre” to “action” and the removal of the reference to harsh braking.

This report will report on incidents recorded as pedal confusion or, where defined as such, unintended acceleration only and not harsh braking.

> Pedal confusion can be defined as the action of a driver confusing the brake pedal and the accelerator pedal thus causing an incident of sudden unintended acceleration of their vehicle

1.7 Format of the report

Following this introduction, the report shows:

Section 2: The literature view of published reports specifically to buses.

Section 3: Profile of those who responded to the online survey.

Section 4: Occurrences of pedal confusion with findings from both the secondary data which includes data by year, by month, day of week, time of day and findings from the online survey.

Section 5: Suggested causes of pedal confusion.

Section 6: Opinions on suggested solutions to pedal confusion and other potential solutions, combining the findings from the secondary data, online survey and workshops.

NOTE: In the survey and during the workshops, some drivers and attendees expressed their belief that fatigue was a potential cause of pedal confusion and as a consequence a reduction in fatigue would reduce the number of emergency situations where pedal confusion may occur. TfL has previously commissioned Loughborough University to complete a study in to bus driver fatigue, therefore this report does not focus on the reasons for, and solutions to, bus driver fatigue.

2. Literature Review

There are very few published reports on pedal application errors specifically related to buses. Those which have been reported have been commissioned mainly by TfL. Other studies into pedal misapplication errors tend to focus on passenger vehicles in general, with research in Japan and the USA exploring age or gender correlations.

There are a number of terms used for 'pedal confusion' including 'pedal confusion', 'pedal application error', 'pedal misapplication' and in some cases, 'unintended acceleration'. For the purposes of this review, these terms may be considered interchangeable.

An approach was made to the International Bus Benchmarking Group (IBBG) of which TfL are members, who kindly provided the Clearinghouse Study from Dublin in 2007, this provided useful guidance, however as this report is not published it is not referenced any further.

The IBBG is a group of bus operators and authorities from around 15 member cities around the world who share best practice on operations. The group undertakes benchmarking on a range of metrics including safety, finance, efficiency and operational practices. All information shared is confidential.

See appendix A for references to each piece of literature reviewed.

2.1 Human Factors – 2011 (TfL)

This report explored possible measures to counter pedal application error. Solutions were assessed by experts to explore the feasibility and potential benefits of each.

a. Standardise pedal layouts – ensure all models of bus use the same standardised pedal layout, so that drivers have a consistent mental model;

b. Seat adjustment controls – improved driving seat controls would allow quicker seat adjustment, particularly for smaller drivers, which would help to ensure a correct driving position, which could reduce the number of pedal errors;

c. Engine cut off when driver door is open – drivers must restart the bus and reposition their foot on the brake pedal to switch from neutral to drive mode, each time the driver's door is opened; and

d) Pedal application error training – provide pedal application error training to help bus drivers to recognise and react to a pedal application error which should help them to recover more reliably.

2.2 Transport Research Laboratory – 2018 (TRL)

A study was commissioned to research a range of safety measures to be included in the Bus Safety Standard (BSS). The safety measures evaluated by TRL were based on the recommendations from the Human factors – 2011 research (section 2.1).

Environmental and safety tests were conducted for feasibility and the development of assessment protocols for an individual vehicle's adherence to the BSS. In terms of pedal application error, recommendations included:

a. Toggling – Drivers should press the brake twice to update the driver's recent memory of the brake pedal position, for example, whilst waiting at a bus stand. If the brain has more frequent updates, drivers are less likely to place their foot incorrectly. This was introduced into the 2021 BSS.

b. Bus Vision Standard – Driver's feet might become misaligned to the pedals if they move to see a blind spot. Additional measures to reduce blind spots will help to reduce unintended acceleration.

c. Standardised pedal placement – Although pedal design is regulated and many manufacturers build to ISO standards, there is still variation between models. TRL suggested that identical layouts could eliminate potential driver confusion.

d. Driver feedback system – In the event of an error, a feedback system may help a driver realise that they have made a mistake. This could be a visual indication (the Pedal Indicator Light was introduced into the 2019 BSS), or engine noise simulation for electric/hybrid vehicles.

e. Future Advanced Emergency Braking (AEB) – If the current AEB system was adapted to recognise the difference between normal acceleration and brake confusion, it could engage emergency braking if the accelerator was depressed fully.

This research takes these recommendations to learn how stakeholders, including drivers perceive each of these as a potential solution.

2.3 Footright – 2015 (TTN Technologies)

Footright is an intelligent safety device designed for buses and coaches. It is specifically designed to eliminate the effects of unintended acceleration incidents. It is designed to be retrofitted to commercial vehicles, demanding a series of inputs before allowing the throttle to be enabled. Other features include variable speed limitation, reverse gear selection warnings and reduced acceleration after the operation of entry/exit doors.

2.4 Pedal Application Errors – 2012 (NHTSA)

The US Department of Transportation's National Highway Traffic Safety Administration (NHTSA) examined the prevalence of pedal application errors and the driver, vehicle, roadway and environmental characteristics associated with them. This was via a literature review, media analysis, crash database analysis, case studies and a panel of subject matter experts. Whilst this study was not limited to buses, it appears to be one of the largest scale examinations into the phenomenon.

Main findings include:

a. There are approximately 15 pedal misapplication crashes* in the USA per month;

b. Two thirds of the drivers of vehicles involved in those crashes* are female;

c. Driver age distribution is concentrated in the youngest (16-20) and oldest (76+) age groups, representing 35-50% of drivers, depending on the data set used; and

d. Passenger cars are the most common vehicle type to experience crashes* due to pedal application errors, correlating with their exposure in the vehicle fleet.

Recommendations include educating medical professionals about conditions associated with pedal application errors so that these can be flagged at routine physical examinations, public education on measures to counteract an unintended acceleration incident and providing law enforcement with a means to record driver details in such incidents.

*NOTE: The NHTSA refers to crashes, not incidents, this terminology has been matched here.

2.5 Additional Studies

In addition to the above studies there are several areas of focus in the wider academic field. There appears to be a particular focus on age, which correlates with the NHTSA age

distribution curve. Several studies have been conducted into the effects of age on pedal application errors, with a focus on older drivers. References are shown in Appendix A.

a) Kinematic and Electrophysical Characteristics of Pedal Operation by Elderly drivers during Emergency Braking;

b) Understanding the Automotive Pedal Usage and Foot Movement Characteristics of Older Drivers; and

c) Pedal Misapplication: Interruption Effects and Age-Related Differences.

3. Profile of respondents to the online survey

3.1 Respondent Profile

In total, 593 respondents participated in the online survey which delivers data. This number of responses provides data with a level of confidence at the 95% level of +/- 4%. However, the responses should not be considered representative of drivers as the survey was self-select and the profile of drivers may skew to those with more experience as shown later in Figure 3.2.

Table 3.1 shows the number of interviews achieved through the online invitation with the link or QR code and those who completed the interview while the interviewer was in attendance using a tablet available for an immediate response.

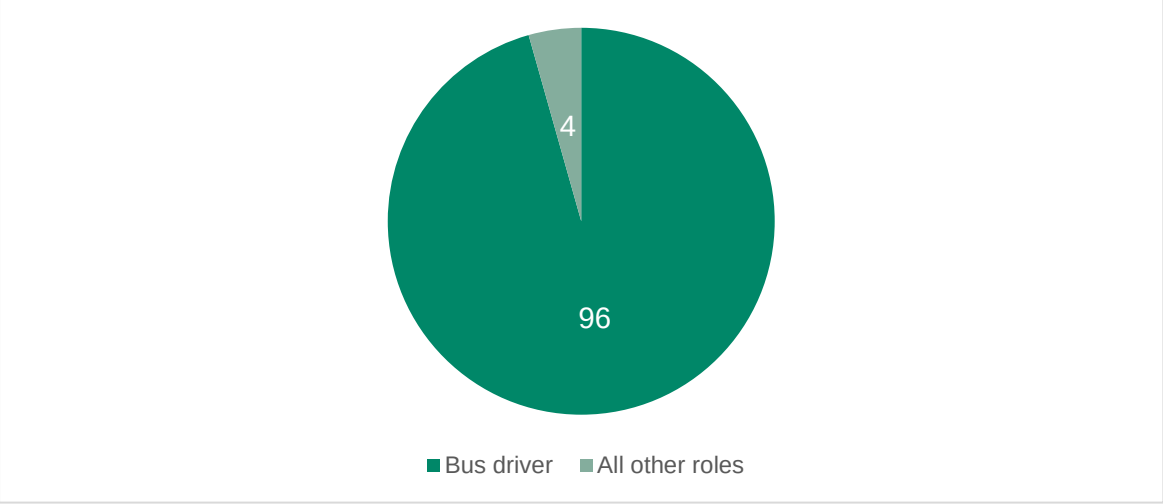
Table 3.1 Number of interviews by time

Time of interview	Number (n)	Percentage (%)
Completed during interviewer visit using a tablet with an online link	402	68
Completed at any other time using a personal device and accessing the online link	191	32
Total	593	100

Base: all respondents (n=593)

The majority of responses to the survey were from drivers as shown in Figure 3.1.

Figure 3.1 Profile of respondents: drivers and other roles (%)

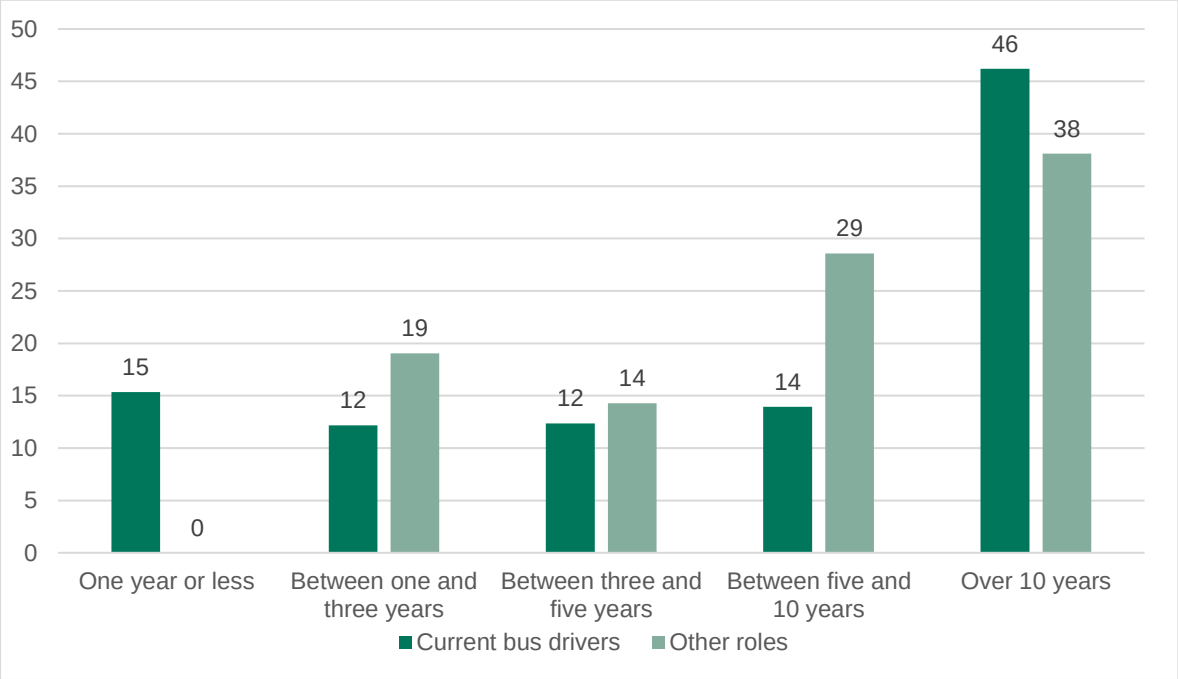


Base: all respondents (n=593)

Of the 593 responses to the survey, 567 (96%) were current drivers. Of the remaining 26 respondents (4%), 21 had previously worked as a bus driver before changing roles, with 5 respondents who worked in the bus garages but had not had a role as a bus driver. In total, 99% of all respondents work or had worked as a bus driver.

Figure 3.2 shows the amount of driving experience of those currently driving and those who had previously been a bus driver but were now in another role.

Figure 3.2 Driving experience (%)

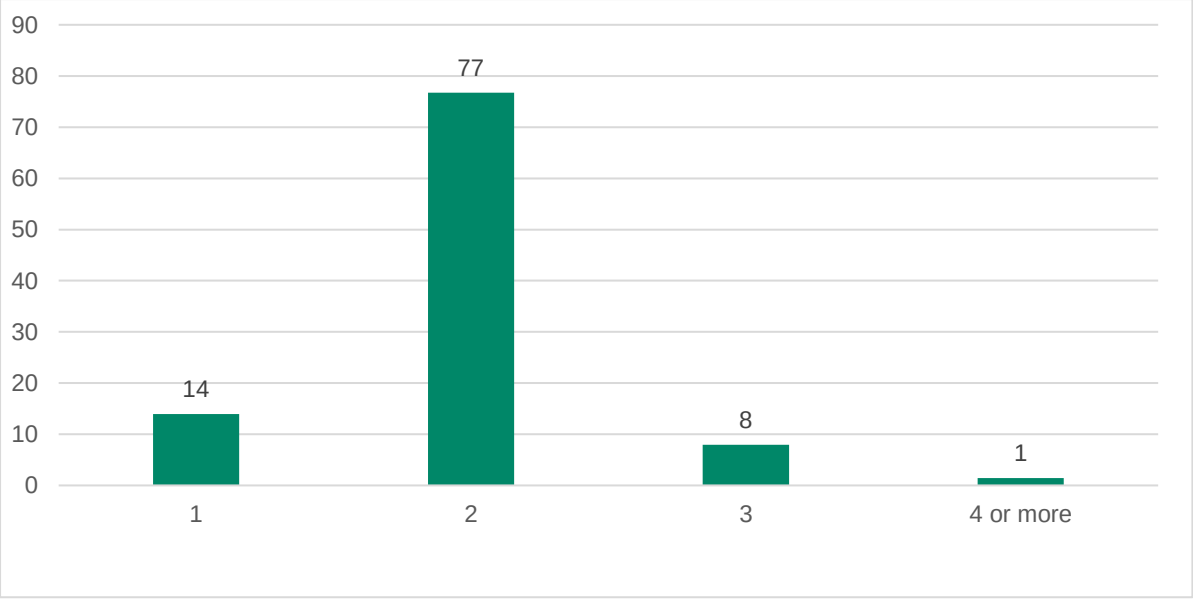


Base: all current bus drivers (n=567); other roles, previously bus drivers (n=21)

Of those who currently drive a bus, 39% have under five years' driving experience and 60% have over 5 years' experience with most of these (46%) having over 10 years' experience.

Figure 3.3 shows the proportion of drivers who stated that typically they drive more than one bus per shift, even if it is the same make and model, with 86% of all drivers stating this.

Figure 3.3 Typically, number of different buses driven per shift per driver (%)



Base: all current bus drivers (n=567)

4. Occurrences of pedal confusion

This section looks at the number of times that pedal confusion is reported to occur, firstly using the IRIS database and secondly the online survey.

4.1 IRIS data

The IRIS database also includes a description of the incident and this account was used to identify cases of pedal confusion incidents.

The IRIS data provided had a total of 363,329 incidents in the five-year period from 2015 to 2019 and includes 64,203 incidents where a bus driver was noted as the primary cause of the incident. In the absence of contributory factors, and without a categorical indication of whether incidents were related to pedal confusion, the analysis of this data focussed on interpreting the incident descriptions. Owing to the vast number of data points held, the methodology focussed on searching for key words in the incident description field to highlight incidents of pedal confusion. Key words searched included ‘pedal confusion’, ‘accelerator’, ‘accelerated’, ‘brake’ and ‘gas’.

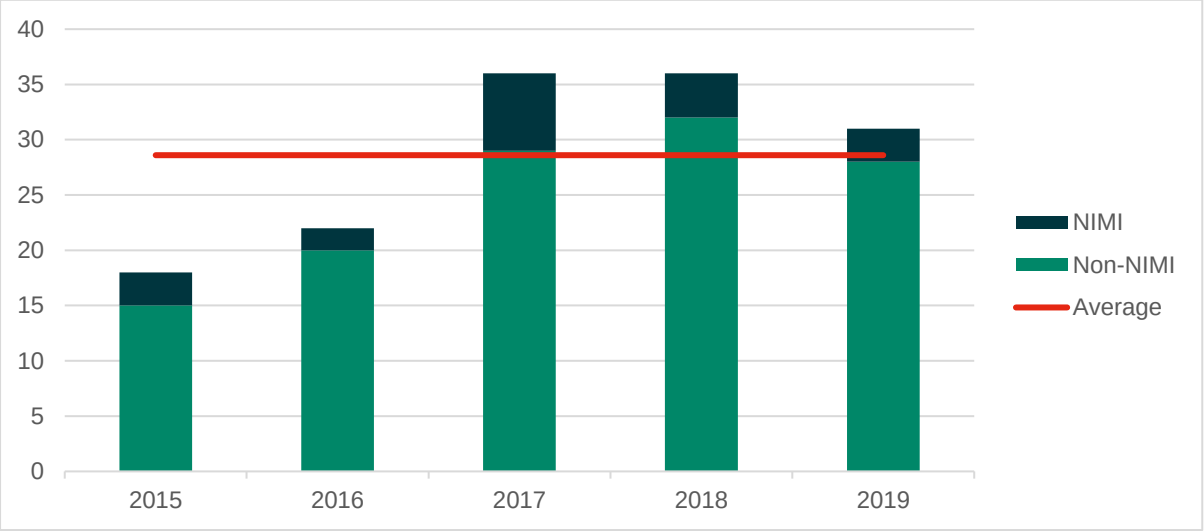
In total, 143 incidents were identified as pedal confusion incidents and of these 19 had been flagged as NIMI (major) incidents.

In addition to the 143 pedal confusion incidents, there were multiple incidents caused by drivers’ failure to apply the handbrake when the vehicle was stationary. These incidents were also highlighted by searching for key words in the incident description field including “handbrake”, “hand brake” and “rolled”. There were 93 of these incidents identified, with two of these incidents then leading to instances of pedal confusion. The incidents which did not lead to pedal confusion were considered outside the scope of the study and were not analysed further.

It is worth noting that the narrative provided in the descriptions varied case-by-case (in particular, the level of description and whether the description was written by the driver or other staff). There was therefore an element of subjectivity involved in the study of this information.

Figure 4.1 shows the number of incidents related to pedal confusion in the IRIS data set recorded over the five-year period from 2015 to 2019. The incidents that had been flagged as NIMI (major) incidents within the IRIS database have been highlighted in the figure below.

Figure 4.1 Number of pedal confusion related incidents by year (n)



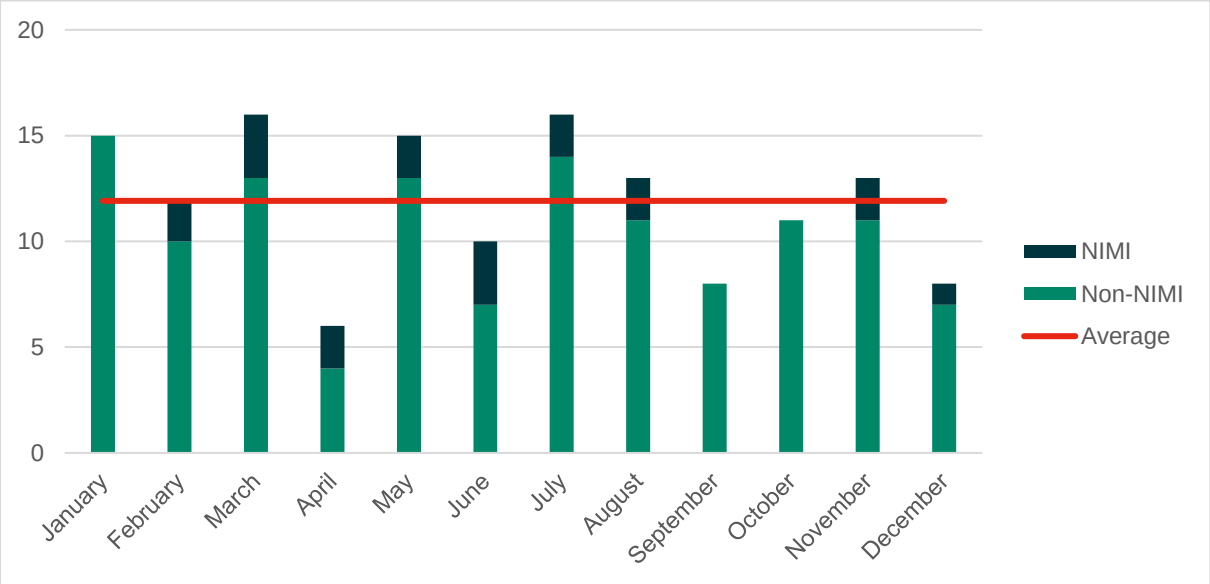
The number of recorded incidents grew considerably from 2016 to 2017 and fell slightly from 2018 to 2019. Given that the period of study was only five years in length, it was difficult to determine whether these changes were significant or whether they were just a natural variation in the number of incidents reported year-on-year. If there is a significant increase, the reasons for this cannot be determined, but may include:

1. Driver willingness to report due to a more open reporting culture;
2. Improved investigation techniques, such as footwell cameras;
3. Changes in bus types being driven, such as more hybrid and electric buses; or
4. More incidents of pedal confusion from any bus type.

Month of year

Figure 4.2 presents the incidents related to pedal confusion in the IRIS database by month for the period 2015 to 2019. The major (NIMI) incidents in the IRIS data set have been highlighted in Figure 4.2 and the average number has been added for comparison.

Figure 4.2 Number of pedal confusion related incidents by month (n)



As can be seen in Figure 4.2, the number of instances of pedal confusion varied considerably by month. For example, there were six reported incidents occurring in April but as many as 16 in March and July. The number of incidents that had NIMI flags in the IRIS database (representing the more serious incidents) also varied by month. There were no NIMI incidents recorded in January, September or October but the majority of the remaining months had at least two NIMI incidents recorded.

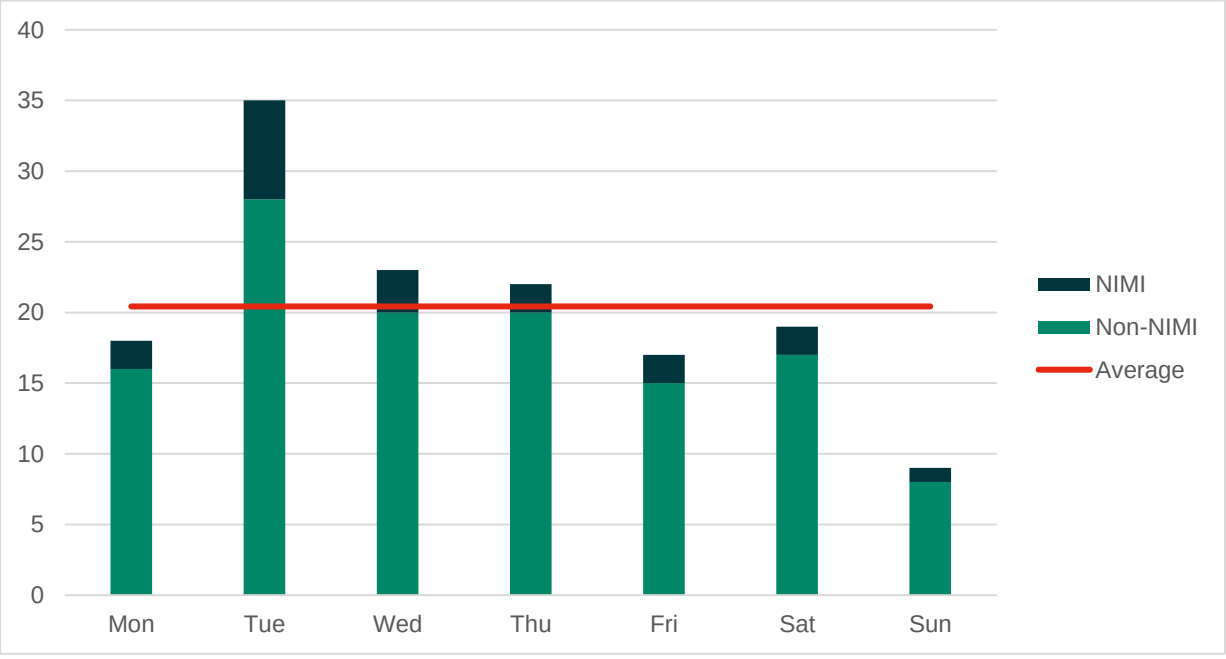
In the IRIS data set, March and July had the highest number of reported pedal confusion incidents (16) and these months were closely followed by January and May which both had 15 reported incidents. The highest number of NIMI incidents was recorded in March (3) however the months with the highest frequency of serious incidents as a proportion of the total incidents that occurred during the month was April (33%) and June (30%).

Whilst the data showed that pedal confusion incidents occurred with a higher frequency in some months than others, the trends were fairly weak and more detailed data would therefore be needed to identify whether there is a relationship between the number of collisions and the month of the year. The limited quantity of NIMI incidents available for study in the IRIS database also meant that it was not possible to determine whether there was a relationship between the month and the incident severity. Further data would also be required to explore this relationship further.

Day of week

Figure 4.3 presents the incidents related to pedal confusion by day of the week and includes the NIMI and non-NIMI data in the IRIS database for the period 2015 to 2019.

Figure 4.3 Number of pedal confusion related incidents by day of the week (n)



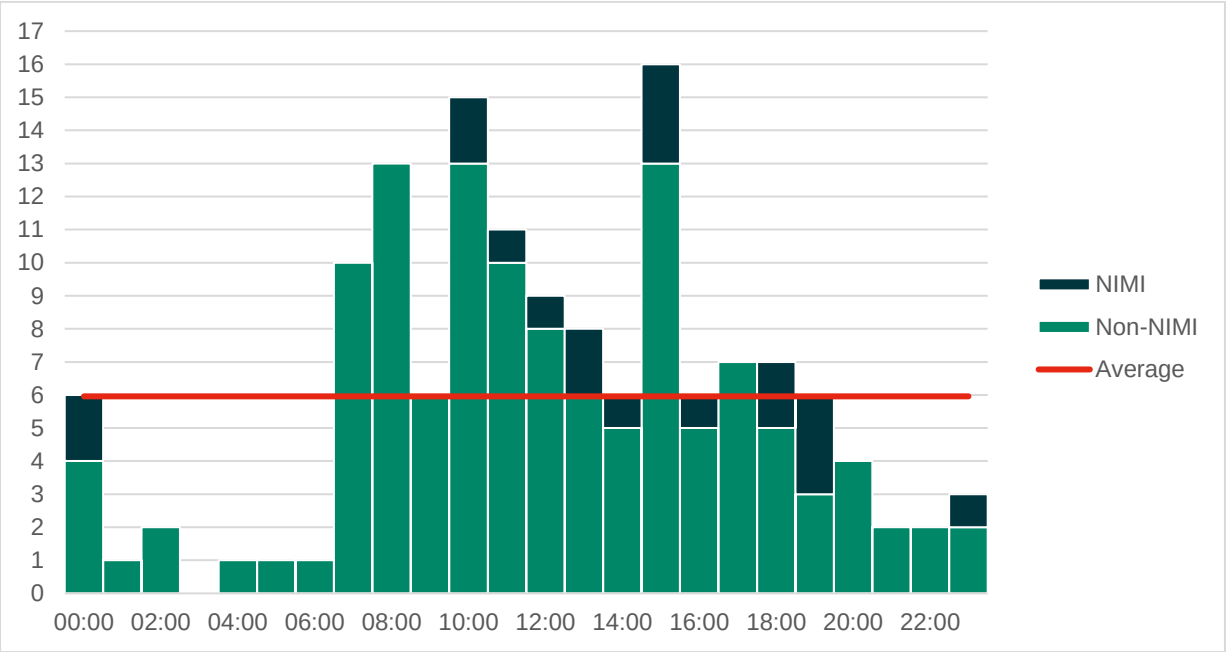
Tuesday clearly had the highest number of reported pedal confusion incidents both in terms of overall number and the number of NIMI incidents. The proportion of the overall pedal confusion related incidents that were classed as NIMI incidents was also highest on a Tuesday (20%). The remaining days of the week, excluding Sunday, all appeared to have a similar level of reported incidents in the IRIS data set (in the range from 17 to 23). There were very few incidents recorded on a Sunday, although this may be because there is a reduced service on a Sunday.

Over the period of study, pedal confusion incidents occurred considerably more frequently on a Tuesday than any other day. Of the relationships studied relating to time of day, day of the week and month of the year, this was the clearest indication that there might be an underlying pattern in the data. It is worth stressing however that data would need to be studied over a longer period to confirm whether this represents a trend or if this was purely coincidental.

Time of day

Figure 4.4 shows how the number of pedal confusion incidents varied by hour of the day and is again separated into NIMI and non-NIMI incidents.

Figure 4.4: Number of pedal confusion related incidents by hour of the day.



There were very few incidents recorded during the early hours of the morning when the traffic on the network was likely at its lowest. The number of incidents recorded increased significantly from 07:00 onwards, which could be linked to a potential increase in traffic volumes during morning rush hours. The hour with the highest number of incidents was 15:00 – 16:00 and this was closely followed by 10:00 – 11:00. Whilst there were a few hours which had higher numbers of incidents recorded, there does not appear to be a significant variation.

The number of incidents recorded was lower for the hours from 20:00 onwards however there was a slight increase in the number of incidents recorded for the hour 00:00 – 01:00. When compared to the hours in the middle of the day, which generally saw higher levels of incidents than the hours during the evening and early hours of the morning, the hour 00:00 – 01:00 does not have a significantly high level of incidents. However, when comparing the six incidents recorded in this hour to the number of incidents recorded in the other hours from 20:00 to 07:00, there is a marked increase in incident levels for this hour.

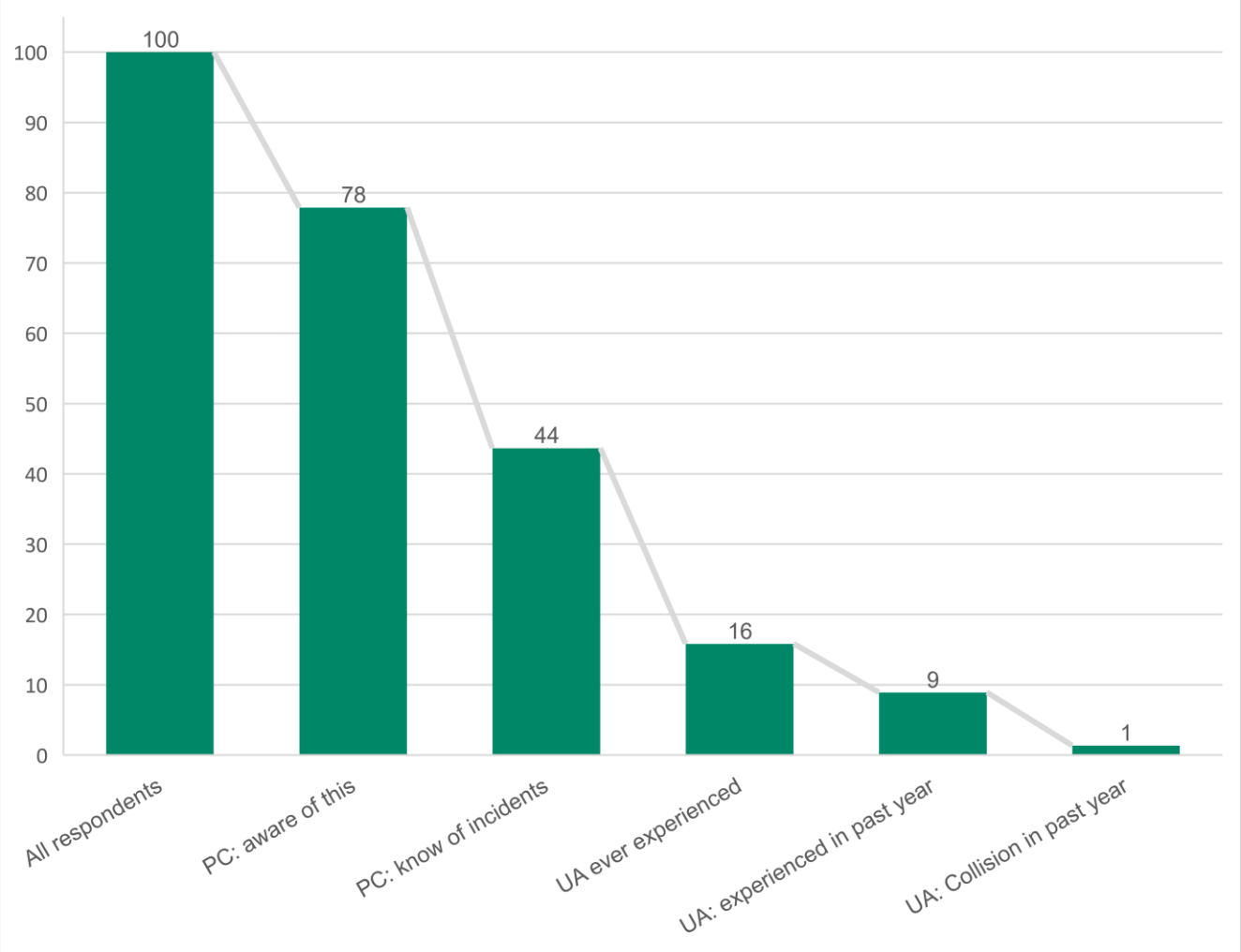
Like many of the findings in this study, more detailed data would be needed to clarify whether the peak in incidents in the hour 00:00 – 01:00 was significant or whether this was purely coincidental. Furthermore, more detailed data would be required to determine if there are hours of the day that have a higher rate of incident occurrence.

4.2 Drivers reporting of pedal confusion

When asked about their awareness and experience of pedal confusion, approximately 1 in 5 drivers were unaware of pedal confusion (22%), 44% had awareness of pedal confusion incidents and 56% were not aware of any pedal confusion incidents.

Figure 4.5 shows the awareness of pedal confusion (PC), which may include harsh braking due to the definition provided to drivers in the survey and those who have experienced unintended acceleration (UA).

Figure 4.5 Awareness of pedal confusion; experience of unintended acceleration (%)



Base: all respondents (n=593)

Occurrences of unintended acceleration

Drivers in the survey confirmed the following, specifically about unintended acceleration:

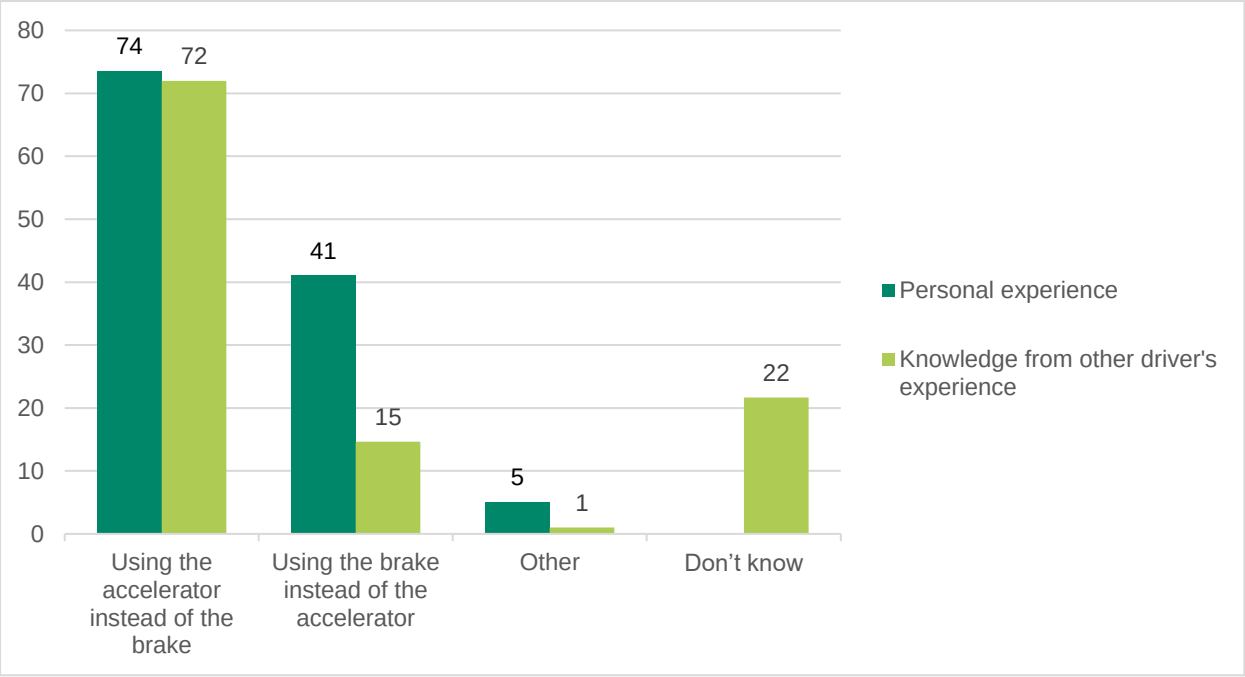
- 16% of drivers have experienced unintended acceleration;
- 9% of drivers experienced unintended acceleration in the past year; and
- 1.3% of drivers experienced a collision due to unintended acceleration

Of the 53 drivers who experienced unintended acceleration in the past year, 85% of these experiences DID NOT result in a collision, these are assumed to be near misses.

Additionally, drivers with less than 5 years' experience are less likely to know of any other drivers' experience of pedal confusion compared with those who have more than 5 years' experience (46% compared to 33%), while the proportion who do not have any knowledge of pedal confusion is similar irrespective of experience.

Figure 4.6 shows whether driver's knowledge and experience about actual incidents were unintended acceleration or harsh braking.

Figure 4.6 Experience of pedal confusion (%)



Base: Personal experience (n=127); Knowledge from other driver's experience (n=157)

This report continues to look at the higher proportion of driver's experience and workshop attendees knowledge, which is unintended acceleration, however, 41% of drivers stated they have used the brake instead of the accelerator, although the outcomes of these types of pedal confusion are unknown.

Of those who experienced pedal confusion, about three-quarters (74%) said they had used the accelerator instead of the brake, while 72% of those who were using their knowledge of other driver's experience understood it was unintended acceleration.

When asked about the anticipated frequency of a pedal confusion incident occurring, many drivers were unsure.

4.3 Summary of pedal confusion occurrences

Findings from IRIS data:

143 pedal confusion incidents reported between 2015 and 2019.

- An average of 29 incidents per year. 19 were flagged as NIMI;
- An average of 2.4 incidents per month;
- Tuesday saw the highest number of incidents (35) and Sunday the lowest (9); and

- The times when the highest number of incidents took place was between 15:00 and 16:00 and between 10:00 and 11:00.

Findings from the online survey

- Approximately 1 in 5 drivers (22%) were unaware of pedal confusion (78% aware);
- 44% had awareness of incidents (56% unaware);
- 16% of drivers reported having experienced unintended acceleration at any time;
- 9% of drivers reported having experienced unintended acceleration in the past year; and
- 1.3% of drivers reported having experienced a collision due to unintended acceleration.

Of the 53 drivers who experienced unintended acceleration in the past year, 85% of these experiences did not result in a collision. This low number means significant conclusions cannot be made and data should be treated with caution and considered indicative.

5. Causes of pedal confusion

5.1 Secondary data

The following section describes the possible causes, other than time of day (see section 4).

5.1.1 NIMI data

Records for each incident included the date of incident, route, operator, and vehicle information; and a brief description of the event and the key findings resulting from the investigation. In addition to the information provided in the database, further information about the 16 cases with completed investigations was obtained, including details of driver shift patterns leading up to the incident and drivers' experience in operating the model of bus involved in the incidents.

As the NIMI data didn't cover the same reporting period as the IRIS data therefore it was not possible to treat the NIMI data as a sub-set of the IRIS data. Additionally, whilst the NIMI records included useful information that was not contained in the IRIS databases (namely shift pattern information, vehicle type and drivers' experience of operating the vehicle involved in the collision), the small number of records available for study meant that it was not possible to draw statistically significant conclusions from the information.

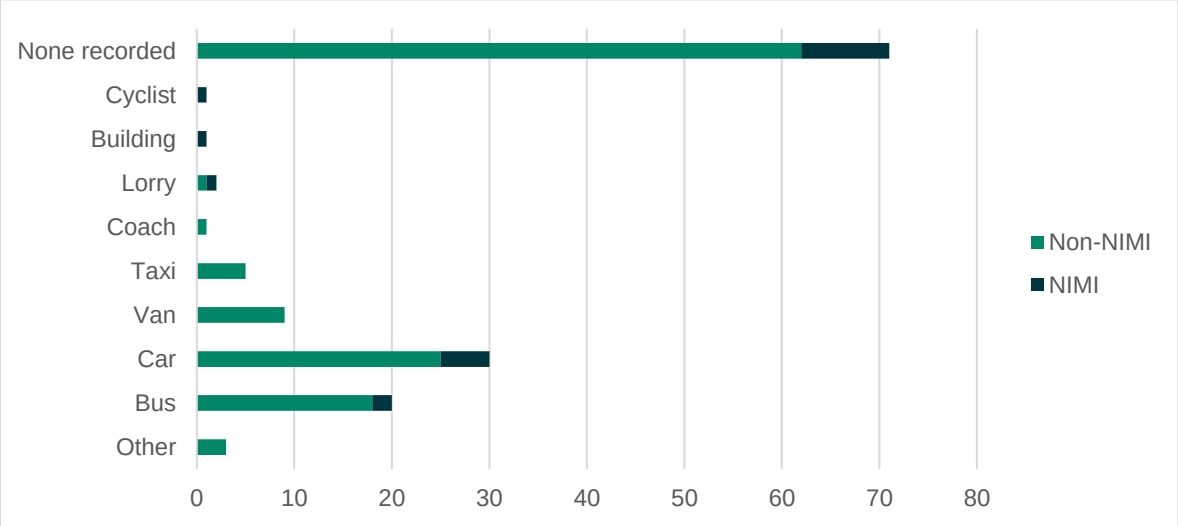
For this reason, the remainder of the analysis focuses on the data in the IRIS databases.

5.1.2 IRIS data

Third party involved

Figure 5.1 splits the pedal confusion incidents with respect to the third party involved in the collision.

Figure 1.1 Number of pedal confusion related incidents by third party involved (n)



Base: 143 pedal confusion incidents

Of the 143 incidents identified in the IRIS database, 71 had no third party recorded despite many of the incident descriptions suggesting that a third party was involved. Most of the

remaining incidents involved cars or buses which were often the nearest object at the point of pedal confusion occurring.

The incident descriptions suggest that many of these incidents occurred while the bus was in stop-start traffic.

Recommendations

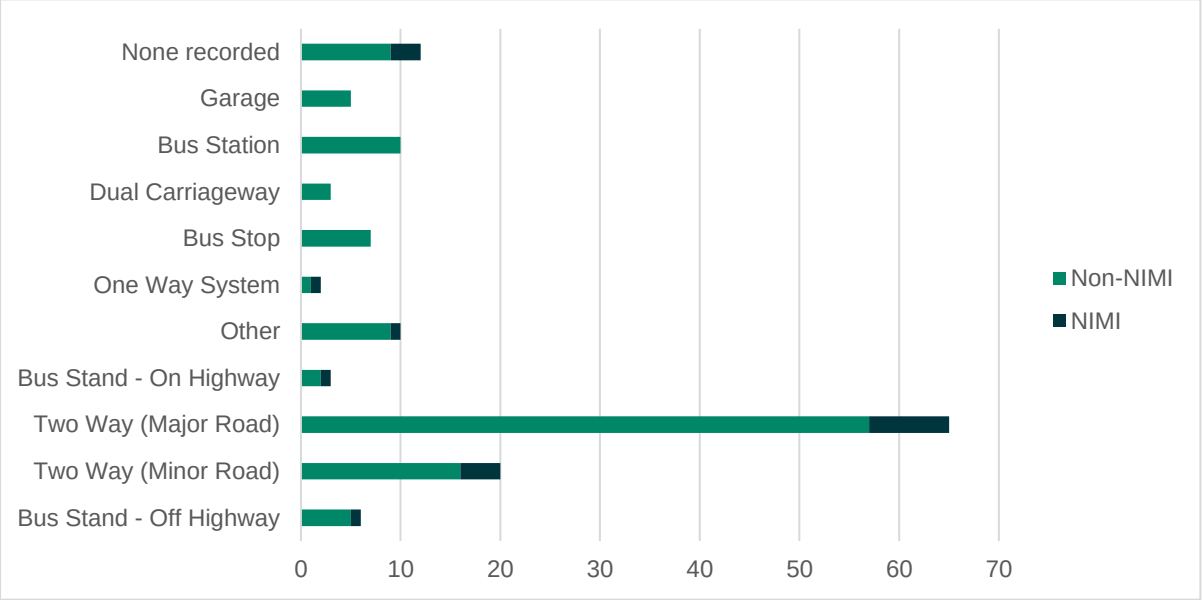
To aid future analysis it is recommended that a comprehensive review of the IRIS and NIMI database fields is carried out, with fields expanded as follows:

- Manoeuvre being performed at the point of the incident;
- Whether the incident is specifically related to pedal confusion;
- Clear details of the vehicle model;
- Drivers' experience in operating the vehicle involved in the incident; and
- Shift patterns or length of time on shift at the point of the incident occurring.

Location Type

Figure 5.2 shows the location of the incidents related to pedal confusion and includes the 143 identified instances in the IRIS database.

Figure 5.2 Number of pedal confusion related incidents by location (n)



Base: 143 pedal confusion incidents

Most of the records had location information included, though there were 12 incidents that were missing this information. Almost half of all incidents occurred on two-way major roads and the next most common location was two-way minor roads. Many of the incident descriptions that had these two locations recorded referred to stop-start periods in traffic or where buses were on approach to bus stops.

Though it appears that incidents are more likely to occur on major and minor roads with two-way traffic, it is important to consider the proportion of each journey spent in these locations. Traffic flow information would need to be considered in further research to allow a better understanding of whether pedal confusion incidents are more likely to occur in these locations

or whether incidents occur more frequently due to the relatively greater time spent in these locations.

Recommendations

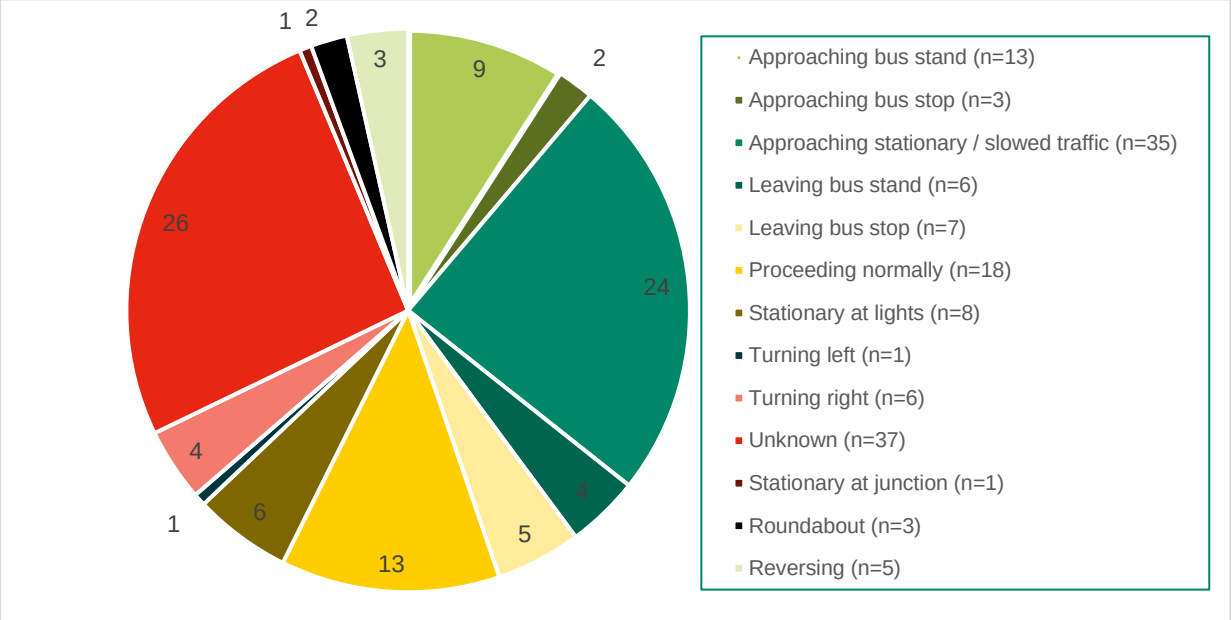
Make sure key fields, such as location, if not all fields, in the database have a forced response when data is inputted.

Measure traffic congestion levels or traffic flow at the incident location at the time of the incident and validate with previous days/weeks at the same time of day to validate if this was usual or unusual.

Manoeuvre Involved

Figure 5.3 categorises the 143 pedal confusion incidents identified in the IRIS database by the manoeuvre that was being performed at the point that the incident occurred.

Figure 5.3 Manoeuvre performed at point of pedal confusion (%)



Base: 143 pedal confusion incidents

The manoeuvre for each incident was determined using the incident descriptions which, for over a quarter of cases, was not clear enough to categorise the incident. Based on the analysis, the most common manoeuvre that led to pedal confusion incidents was 'approaching stationary / slowed traffic'. Almost a quarter of all incidents occurred under these circumstances. Further evidence would be needed to confirm whether there was an increased frequency of pedal changes in slowed or stationary traffic which may be a contributing factor. Other manoeuvres with a significant share of the total incidents included 'proceeding normally' (13%) and 'approaching bus stand' (9%).

Given that it was not possible to determine the manoeuvre for such a high proportion of the incidents, it was difficult to identify patterns in the data. A clearer, more consistent method for recording this data would be required to delve into this.

Recommendations

Add a data field or fields which clearly state the type of manoeuvre being completed to reduce the proportion of unknown manoeuvres. The list in this report could be used as a starting point, with a comments box for additional detail.

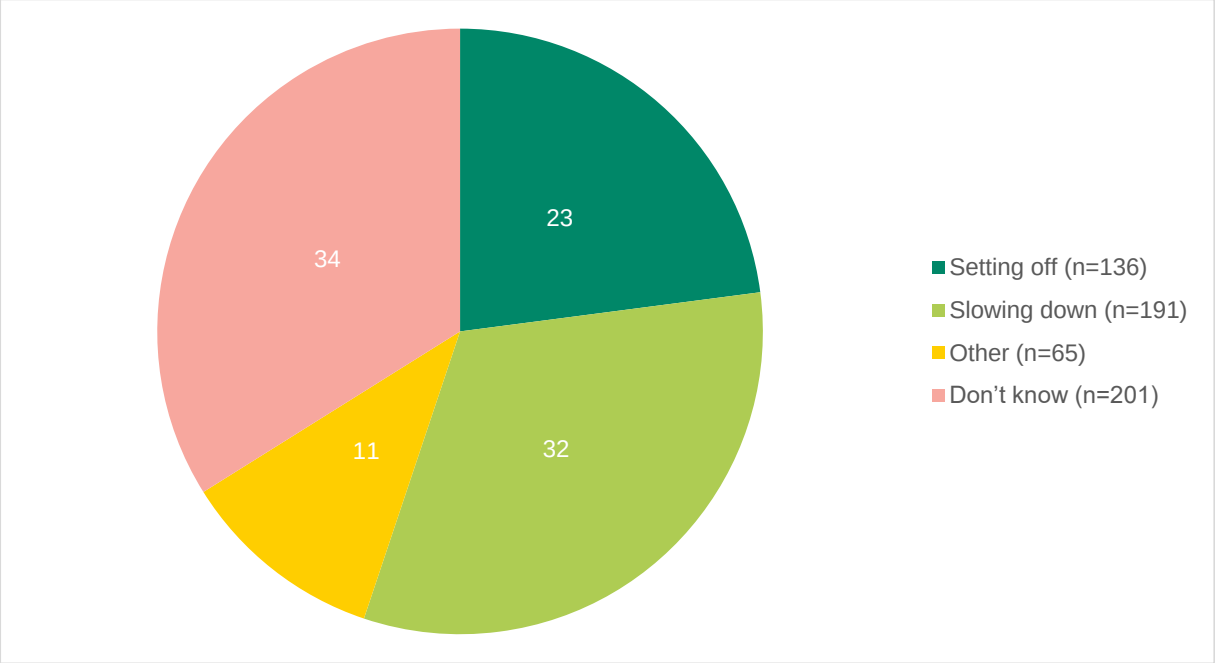
Consider using technology such as footwell cameras to measure and record whether the number of pedal changes were high, regular or low. The definition of high, regular, low and the number in the scale would be better determined by TfL and other experts.

5.2 Online survey

5.2.1 When might pedal confusion occur

Drivers were asked when they believed pedal confusion was most likely to occur and the point in a shift it is most likely to occur. Figure 5.5 shows the outcomes, where setting off and slowing down includes from a garage (depot), from a bus stop or at a junction. Figure 5.6 shows the outcomes by shift.

Figure 5.5 Driver opinion: When is pedal confusion most likely to occur (%)

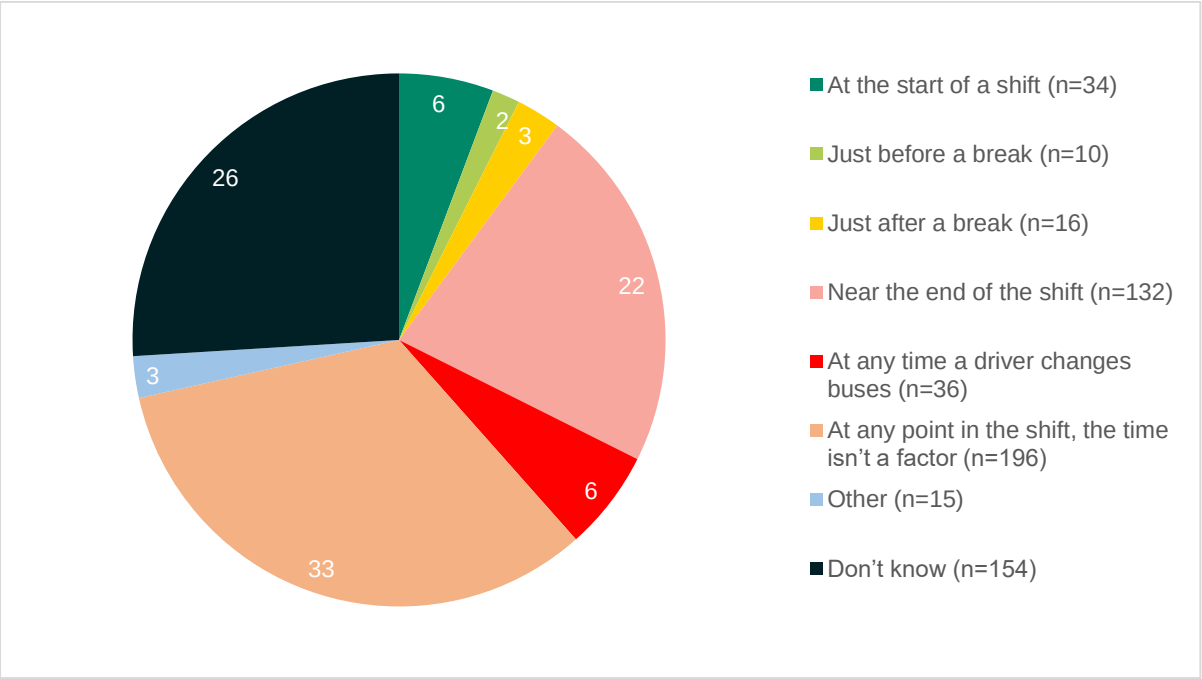


Base: all respondents (n=593)

Similar to the manoeuvre data, the breadth of response varied, including 34% who felt they didn't know enough to answer. The other responses were mainly:

- At any time (n=16);
- Slowing down and sitting in slow moving traffic (n=14); and
- Others such as along a straight road, when tired and that it does not happen.

Figure 5.6 Driver opinion: When in a shift is pedal confusion most likely to occur (%)



Base: all respondents (n=593)

In total, 33% of drivers felt that pedal confusion could occur at any time, and when those who stated they don't know are removed, this increases to just over half the drivers (52%). In addition, drivers who had experienced pedal confusion previously were more likely to say that pedal confusion is most likely to occur at any point in the shift compared to those who had not experienced pedal confusion (50% compared to 29%).

When drivers were asked for reasons, they felt these specific timings were most likely to be when pedal confusion might occur, the main reasons provided were consistent, irrespective of the time selected, and mainly:

- Long shifts, not enough rest time and time between shifts;
- Hurrying, rushing or panicking, or feeling under pressure; and
- That pedal confusion can happen at any time, therefore it's not possible to give a most likely time.

As referenced in section 1.7 of this report, a separate report TfL has previously commissioned Loughborough University to complete a study into bus driver fatigue[3].

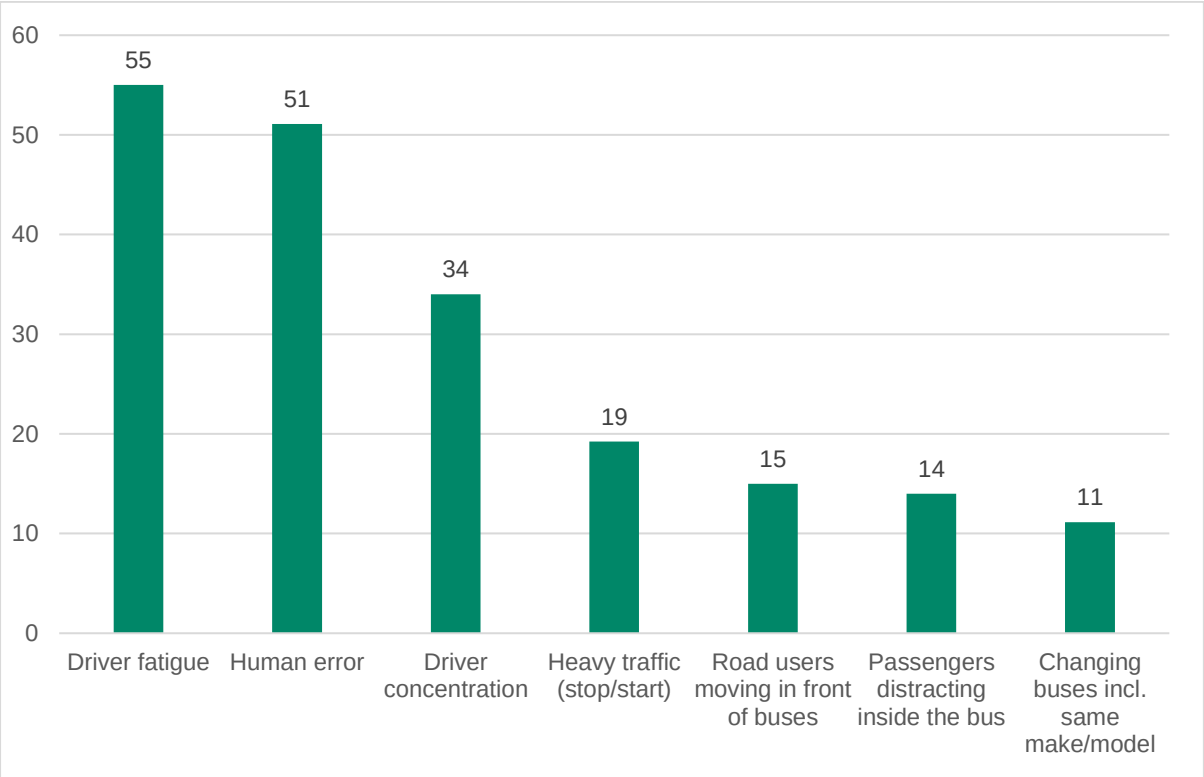
5.2.2 Main factors that cause pedal confusion to occur

Respondents were asked to give their opinion of the top three reasons they believed may cause pedal confusion and given an opportunity to offer any other reason not provided on the list of 14 potential reasons they had been asked to consider. The findings are based on their opinion and does not assume it is evidence based.

Figure 5.7 shows all the possible causes of pedal confusion that drivers gave an opinion on, those selected by at least 10% of respondents are included.

[3] https://content.tfl.gov.uk/bus-driver-fatigue-report.pdf

Figure 5.7 Driver opinion: Factors most likely to cause pedal confusion (%)



Base: all respondents (n=593)

The three main causes in drivers opinion are: driver fatigue, human error, lack of driver concentration. In total, 49% of drivers mentioned at least one type of driver distraction (driver concentration, passenger distraction or pedestrian distraction).

The other options, in order of selection by respondents were:

The other options, in order of selection by respondents were:

- Other road users (7%);
- At blind spots (6%);
- Distraction by pedestrians outside the bus (6%);
- At bus stops (5%);
- Drivers unable to hear the acceleration (4%);
- Pedal shape, placement or layout (4%);
- Rushing or panicking, feeling under pressure (4%);
- Stress (3%);
- Driving when dark (2%); and
- Driving a night bus (2%).

Drivers with over 5 years' experience were more likely to feel that fatigue was one of the three main causes compared to drivers with under 5 years' experience (60% compared to 48%), although both levels of experience ranked this highest as a possible cause.

Drivers who had experienced pedal confusion previously (n=127) listed human error (54%), driver fatigue (51%), driver losing concentration (31%) and driving in heavy traffic (27%) as the most likely causes of pedal confusion.

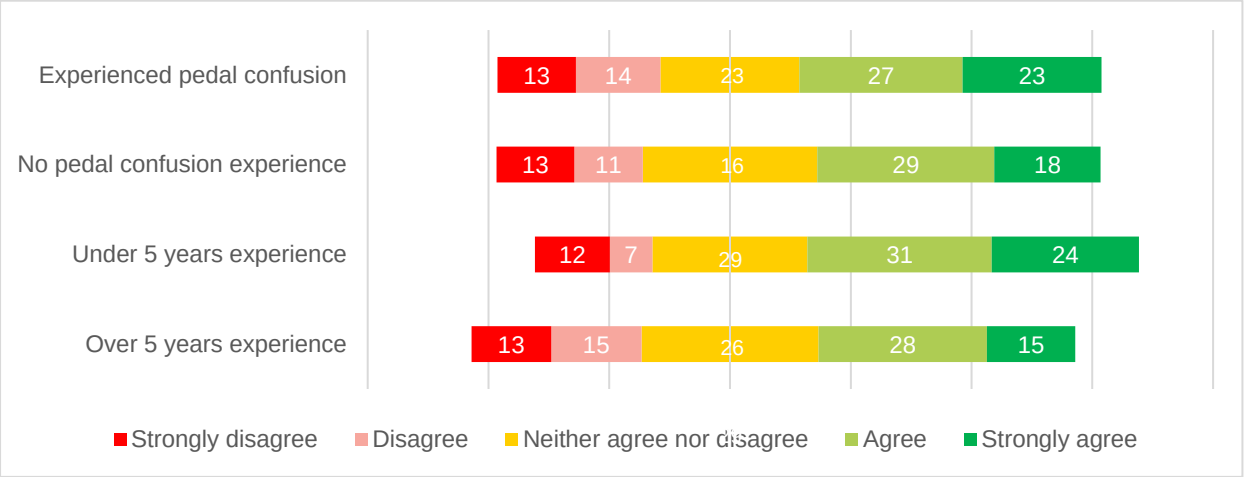
5.2.3 Driver training

Drivers were asked about how much they agreed with the following statement:

"I have been trained to recognise when unintended acceleration is occurring and how to respond to it"

Figure 5.8 shows the responses from drivers based on their driving experience and personal experience of pedal confusion.

Figure 5.8 Driver opinion: Training on unintended acceleration (%)



Base: all current bus drivers (n=567)

More drivers with under 5 years' experience agree with the statement than those who have over 5 years' experience (55% compared to 43%). However, there is no significant difference in the views between those who have and have not experienced pedal confusion.

5.3 Workshops

The causes and occasions when drivers thought that pedal confusion might occur were discussed in all workshops. Table 5.1 outlines the workshop and day-to-day roles of attendees in each workshop. A total 86 stakeholders participated in the workshops. In addition, of 45 drivers participated in separate workshops with 2 to 4 drivers attending each session.

Table 5.1 Stakeholder workshops and roles of attendees

Workshop	Representing	Roles and responsibilities of attendees
1	Bus manufacturers	Bus manufacturers
2	TfL	Health and safety experts
3	TfL	Operations experts
4	Bus operators	Health and safety experts
5	Bus operators	Operations experts
6	Bus operators	Incident investigators
7	Bus operators	Driver trainers
8	Union representatives	Bus operator staff nominated representatives
9	Union officials	Union officials
10	TfL and bus operators (combined group)	Engineers

The outcomes of these workshop discussions have been divided into possible causes related to the vehicle and driving conditions and possible causes that related to a driver.

Everything stated in the workshops was the attendees own opinion based on their experience and was not evidence based. Quotes from the workshop about each topic are shown in Appendix F.

5.3.1 Possible Causes: Vehicle and driving conditions

Many of the workshop respondents thought that similar aspects of the vehicle might contribute towards pedal confusion including:

Different pedal configurations or cab design

Attendees pointed out that pedals differ from bus to bus, both make and model, which means this is something drivers have to get used to, 86% of drivers state they drive more than one bus per shift (see Figure 3.3). Bus drivers thought that electric buses and the New Routemaster bus had pedals that were particularly close together.

The gap between the accelerator and brake pedals, the type of pedals and the height of pedals were all areas of discussion in many of the stakeholder workshops. These features are regulated by national and international regulations. The view was that generally drivers were able to use both pedals by swivelling their foot at the heel (which is a poor driving technique), rather than lifting their foot (which is the driving technique taught to new drivers).

There was a very small piece of analysis completed by one bus operator health and safety expert with a very small sample of six to seven incidents, which is insufficient to draw conclusions. In the small sample, the pedal layout wasn't found to be a consistent reason for the incident, however pedal layout could not be ruled out as a factor either

It is noted that Pedal Standardisation is on the roadmap for the Bus Safety Standard.

Traffic

While it was agreed by most respondents that pedal confusion could occur at any time, it was noted throughout the groups that pedal confusion tends to happen at slow speed and in heavy traffic building upon the evidence from the IRIS data. Further analysis may be required to understand what the contributory factors are that lead to pedal confusion in these instances.

Hybrid and electric buses

There was a view that the acceleration in electric buses, as well as being quieter, was quicker compared to diesel buses.

Some stakeholders thought that regenerative braking on hybrid and electric buses contributed to pedal confusion. The view held by some stakeholders is that during regeneration as the bus slows down the driver may falsely believe their foot is on the brake pedal and this may not be the case. In an emergency situation, those who thought this may be happening also thought that when the driver intends to press the brake the driver is likely to press the pedal as hard as possible but does not realise their foot is on the accelerator.

Footwear choice / lack of feeling of the pedals underfoot

Stakeholders thought that that footwear could make a difference to what the drivers can feel underfoot. Union representatives had a view that drivers do not always wear appropriate footwear. Some drivers in other workshops added similar points.

Driving different models of bus on the same shift / general unfamiliarity with the bus design

Some drivers are required to drive more than one bus per shift, as referenced in section 5.2 of this report. Some drivers we spoke to felt this could potentially contribute towards pedal confusion.

It is noted that Pedal Standardisation is on the roadmap for the Bus Safety Standard.

Recommendations

Explore pedal differentials such as height of pedals and spacing between pedals further. Analyse pedal layouts on all 143 previous incidents, where data is available.

Ensure pedal layout, pedal types, height and spacing are recorded on future incident investigations and included in the IRIS database.

Review current bus operator driver training for correct use of pedals.

Conduct further analysis to understand whether travel at slow speed and/or heavy traffic is a contributory factor and if so, further work such as driver training to be determined.

Conduct further analysis to measure brake regeneration in hybrid and electric buses as a possible cause using current data and/or track tests with drivers.

Review whether footwear has a link to pedal confusion incidents or near misses by reviewing current evidence. If a link is found, further work on footwear requirements should follow and footwear type and condition to be considered to be added to the IRIS database.

Confirm whether bus operators have a footwear regulation or guidance for drivers and where this is the case, review the regulation or guidance.

5.3.2 Causes: Driver related

Driver distraction and driver pressure were mentioned as possibly contributing to pedal confusion by stakeholders across all workshops. In some cases, it might be that these are causes of an emergency situation rather than a direct cause of unintended acceleration. Where a workshop participant thought there may be a direct link these are discussed below.

General driver distraction

Drivers may become distracted for many reasons such as:

Radio controllers contacting drivers

A small number of drivers mentioned that bus operator radio controllers contacting them whilst driving and the pressure they feel to answer the radio before they have managed to stop the bus might contribute towards pedal confusion occurring.

The operator health and safety discussion built on this point further by identifying that the radio button to speak to controllers is on the floor and while drivers should not be in contact with controllers while driving this may not always be complied with.

Passengers / passenger behaviour

Respondents pointed out that drivers may be distracted by passengers' behaviour on the bus behind the driver or when passengers talk directly to them.

Other road users' actions / road conditions

Bus drivers in the workshops described feeling that they have to concentrate hard as they need to read the road ahead, be aware of pedestrians, cyclists and other drivers as well as reading the traffic and safely stopping the bus. Some actions of others around them may cause them to perform an emergency stop or cause panic braking.

Respondents also discussed other possible causes of pressure that could cause driver distraction which have the potential to contribute towards a pedal confusion incident. These included:

Home life pressures (need to pick the children up, family commitments)

A number of respondents provided their view that external timing pressures with family commitments will sometimes cause a driver to rush or to be thinking about that rather than the driving of the bus. Their belief is that rushing to a finish can potentially contribute to an incident of pedal confusion occurring.

Drivers rushing: To achieve their stand time or to finish a shift

Some respondents thought that traffic or incidents on the road may result in buses falling behind schedule and that in these incidences drivers may feel under pressure to make up the time to get back to the depot and not have a route running late.

No toilet facilities in rest areas

One driver felt that in some cases, no facilities at one end of a route may lead to a loss in concentration later during the shift.

Tiredness / fatigue

Some respondents thought that on some days drivers will just be tired or fatigued and therefore their attention to detail and to their driving may not be as accurate or as focused than other days when they are not feeling as tired.

As referenced in section 1.7 of this report, a separate report TfL has previously commissioned Loughborough University to complete a study in to bus driver fatigue[4].

Recommendations

Review current technology that uses sound to alert drivers to a potential incident to assess if a similar method and any learnings can be applied as an effective intervention for pedal confusion.

Identify whether there is a link between driver fatigue and pedal confusion*

Explore how driver stress can be managed for each possible circumstance*

- Communication with radio controllers; type of communication such as late running and driver response and impact on driver**.
- Personal pressure: Drivers want or need to meet timings
- Personal pressure: Home life problems impact on driver concentration

Explore how passenger distraction can be minimalised, for example through driver training, improving passenger information to answer common questions and improved customer education on not speaking to the bus driver whilst the vehicle is in motion.

*Outcomes may be linked to the Loughborough study about driver fatigue.

**Review bus operator policy about communication with drivers whilst driving including:

- Bus operator policy;
- Guidance in the Big Red Book and whether this can be improved; and
- Whether best practice from both the bus operator policy and the Big Red Book can be integrated.

[4] https://content.tfl.gov.uk/bus-driver-fatigue-report.pdf

6. Solutions

6.1 Introduction

Those who responded to the survey and attended the workshops were asked for their views about possible solutions to pedal confusion, using a defined list based on previous research in 2018 and further investigation by TfL since.

This section uses the opinions of those who participated in the survey and the workshops. In the workshops, attendees often clarified there was no data evidence for their views, only their opinion, and often stated more data was needed to validate their opinion.

Recommendation:

Opinions reported in this section should be reviewed by gathering and analysing data which either proves or disproves the view and provides a sense of scale to the value of the solution.

As described in section 3, 96% of those who responded to the online survey were current drivers. In the online survey, respondents were asked for their level of agreement about various solutions and whether they would reduce pedal confusion.

These responses have been ranked based on the difference between those agreeing and disagreeing, as shown in Table 6.1

Table 6.1 Possible solutions to reduce pedal confusion in rank order

Possible solution	Ranking	Net Percentage
Improved driver training about pedal confusion	1	75
Giving drivers time to prepare when changing buses	2	69
*Having the same types of pedals and pedal layout for all makes/models of bus	3	68
*Making sure drivers can see all around the exterior of the bus before setting off, i.e. no more blind spots	4	59
Using the same bus for the whole shift	5	44
*Having a visible cue, such as a light, to inform the driver when the accelerator and brake pedal are being pressed	6	42
Drivers being provided with approved footwear to be used when driving buses	7	42
* Forcing a driver to apply the brake pedal before engaging a gear to drive away[1]	8	41
*A detector to automatically brake, based on sensors which deem when a bus is likely to be unintentionally accelerating	9	41
*Having an audible cue to inform the driver when the bus is accelerating from a low speed or stationary position	10	29

Base: all respondents (n=593)

[1] Description provided to drivers in the survey as some drivers may be unfamiliar with the term brake toggling.

*These are the six possible solutions already included in the BSS roadmap for new build buses and were the ones discussed in more detail in the workshops.

The remainder of section 6 will look at the benefits and limits of each of the six solutions discussed in the workshops as well as other solutions suggested that were not listed.

Everything stated in the workshops was the attendee's own opinion and was not evidence based. Quotes from the workshop to demonstrate each topic is shown in Appendix G.

6.2 Suggested solutions

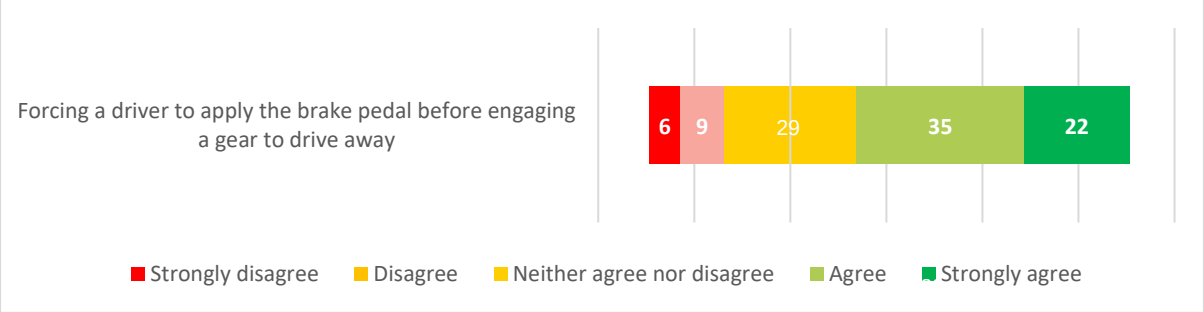
6.2.1 Brake toggling

Brake toggling was introduced during the discussions using the text below. All workshop attendees were advised this was introduced into the 2021 BSS and required on all new buses being delivered that meet the 2021 BSS specification.

> This solution would enable the driver to re-initialise their right foot/driving position and update recent memories of the brake position before leaving a bus stand/stop. This is achieved by the driver needing to double tap the brake before the bus will move forwards (accelerate).
>
> This solution would also avoid errors linked to drivers not following expected driving operations when stopped at a bus stop/stand.
>
> The addition of such a solution could be fitted on an operated bus as long as (light) training is provided to the drivers.

The drivers who answered the online survey saw this described in a more succinct way as shown in Figure 6.1.

Figure 6.1 Brake toggling: Opinions from the online survey (%)



Base: all respondents (n=593)

Over half (57%) of respondents (drivers) either strongly agreed or agreed that brake toggling would be a possible solution with an overall ranking of eight out of the ten suggested solutions.

Opinions of workshop attendees about benefits and limitations of brake toggling

Main Benefit: Expected to be more useful when the bus sets off

Main Limitation: Not expected to be as useful when the vehicle is in motion

Context: 59% of incidents occur when the vehicle is moving;

16% as the vehicle is setting off;

Context (cont.) 26% unknown.

Reference: Figure 5.3 of this report

Topic: Brake toggling as a benefit

Many of the workshop attendees recognised that a clear benefit of having brake toggling was the idea of making drivers find the two pedals sequentially and therefore promoting muscle memory.

A possible additional benefit is for times when buses are in stop-start, heavy traffic.

Topic: Brake toggling as a limitation

The main limitation is the requirement for brake toggling when the vehicle sets off, when more incidents occur when the vehicle is approaching a stop or stand.

Recommendations for brake toggling

Monitor any future pedal confusion incidents and any near misses, with a record of whether the vehicle involved had brake toggling.

In cases where a bus involved in an incident had brake toggling, record the time and/or distance the bus was last stationary to validate whether a driver had driven for a sufficient time or distance to mis-align their foot placement.

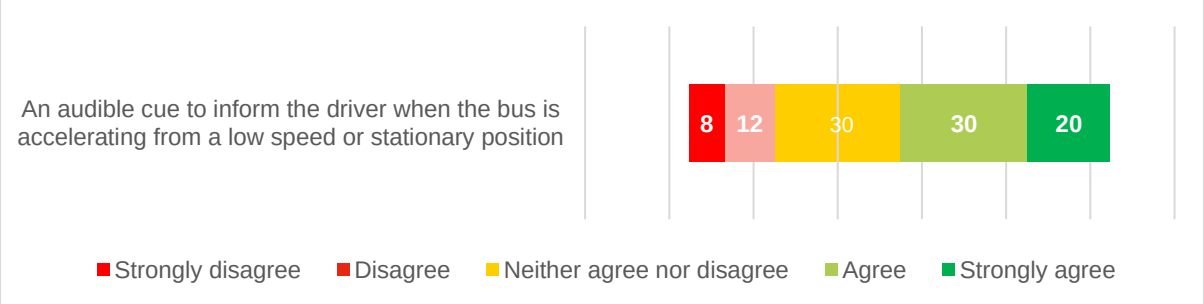
6.2.2 Pedal Acoustic Feedback (audible cue)

Pedal Acoustic Feedback was introduced during the discussions using the text below. All workshop attendees were advised that Pedal Acoustic Feedback had been a requirement of the 2021 BSS. To note, implementation has been paused until the completion of this research.

> Add / Amplify an accelerator engine sound when the bus is in electric mode and at low speed (below 20mph).
>
> The selected sounds to be tested will be fitted in the cab using a speaker/sounder at a predetermined noise level.

The drivers who answered the online survey saw this described in a more succinct way as shown in Figure 6.2.

Figure 6.2 Pedal Acoustic Feedback: Opinions from the online survey (%)



Base: all respondents (n=593)

50% of respondents (drivers) either strongly agreed or agreed that accelerator sound would be a possible solution with an overall ranking of ten out of the ten suggested solutions, with 20% of respondents either strongly disagreeing or disagreeing, the most for any of the ten possible solutions.

Opinions of workshop attendees about benefits and limitations of Pedal Acoustic Feedback

Main Benefits:	It may help drivers who don't realise their bus is still moving.
	It may alert the driver's attention through the action
Main Limitation:	Expectation / reliance remains with the driver to respond
Context:	It may alert the driver's attention but the action and response remains with the driver
Pre-conception:	Drivers who have driven with AVAS on electric buses hold a concern about any sound used being continuous and therefore irritating, and this pre-conception needs to be considered and overcome.

Topic: Accelerator sound as a limitation

The views widely expressed by workshop attendees was that the audible cue would create the need for a response or reaction from a driver, which means the reaction time of the driver between the audible cue being heard, the brake being applied and the stopping distance for the bus would all be factor.

Over time, with all other sounds in the cab this would become white noise to a driver.

There was still some reliance on the driver to realise there was unintended acceleration and to respond correctly. The opinion of workshop attendees was there are too many sounds already for a driver to distinguish.

Topic: Past experience

Health and safety teams commented they had tried something similar before and they did not see it as successful, and therefore their opinion is the sound does not get past the limitation of human nature and reaction time.

Recommendations for Pedal Acoustic Feedback (audible cue)

Use learnings from Acoustic Vehicle Alerting System (AVAS) project to support development of a suitable Pedal Acoustic Feedback sound including gaining buy-in from drivers.

Explore the possibility and "need" for a consistent sound on all bus makes and models as described by the TfL Operations team.

Consider using the accelerator sound as a multi-beneficial addition to improve driving style as suggested by bus manufacturers.

Monitor any future pedal confusion incidents and any near misses, with a record of whether the vehicle involved had an accelerator sound.

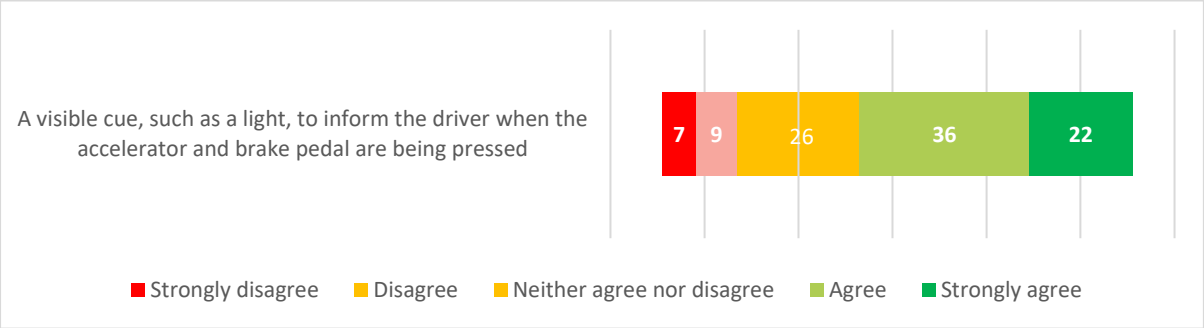
6.2.3 Accelerator/Brake light indicators (visual cue)

Accelerator / Brake light indicators was introduced during the discussions using the text below.

> Add two LEDs/lights (one light for the brake pedal activation, one light for the accelerator pedal activation) to a bus dashboard.
>
> The LEDs/lights should be dimmed between day/night conditions.
>
> NOTE: Pedal indicator lights were a requirement of BSS buses from 2019

The drivers who answered the online survey saw this described in a more succinct way as shown in Figure 6.3.

Figure 6.3 Accelerator/Brake light indicators: Opinions from the online survey (%)



Base: all respondents (n=593)

58% of respondents (drivers) either strongly agreed or agreed that accelerator/brake light indicators would be a suitable solution with an overall ranking of six out of the ten suggested solutions.

Opinions of workshop attendees about benefits and limitations of accelerator /brake light indicator

Main Benefits:	The light shows both accelerator and brake pedal use
	Probably quick and cheap to implement compared to others
Main Limitation:	Expectation / reliance remains with the driver to respond
Context:	There are a number of light displays on the dashboard for various notifications such as engine warnings; stop request; economical driving, a widely held view is this would become another light, drivers would not pay attention to and its value will become redundant

Topic: Accelerator / brake light indicator as a benefit

Drivers saw the benefits of a visual cue compared to an audio cue as it would act as confirmation of the current action for the driver.

A number of respondents liked the simplicity of lights showing up when they press on the brake or accelerator, thought this could be simple to implement and offer some benefit to help reduce pedal confusion as it could easily identify the pedals for the driver.

Topic: Accelerator / brake light indicator as a limitation

Workshop attendees held the opinion that drivers ignore LEDS, partly because drivers might not know what all the different lights do, and there are too many lights on the dashboard already.

In the same manner as the accelerator sound, the opinions of workshop attendees held is this is still reliant on a driver's reaction and understanding. Over and above an accelerator sound, they felt having such lights could have a negative impact, if drivers are checking the light and not the road ahead.

The potential for the driver to remove their eyes from the road, led one Union Official to state their belief that there would be more benefits to an audio cue rather than visual cue and a manufacturer agreed.

Recommendations for accelerator / brake light indicators (visual cue)

Undertake a review of the benefits and limitations of accelerator / brake light indicators on existing BSS vehicles in the fleet, including but not limited to the positioning of the lights in relation to the driver's line of sight and colours used.

Monitor any future pedal confusion incidents and any near misses, with a record of whether the vehicle involved had an accelerator and brake light indicator.

6.2.4 Improved Direct/Indirect vision for a driver inside the cab

Improved direct/indirect vision was introduced during the discussions using the text below. All workshop attendees were advised this was introduced into the 2021 BSS.

Use of additional visual aids to drivers to check all areas and reduce the need for body movement (including foot movement leading to misplacement) in the driver cab when making manoeuvres.

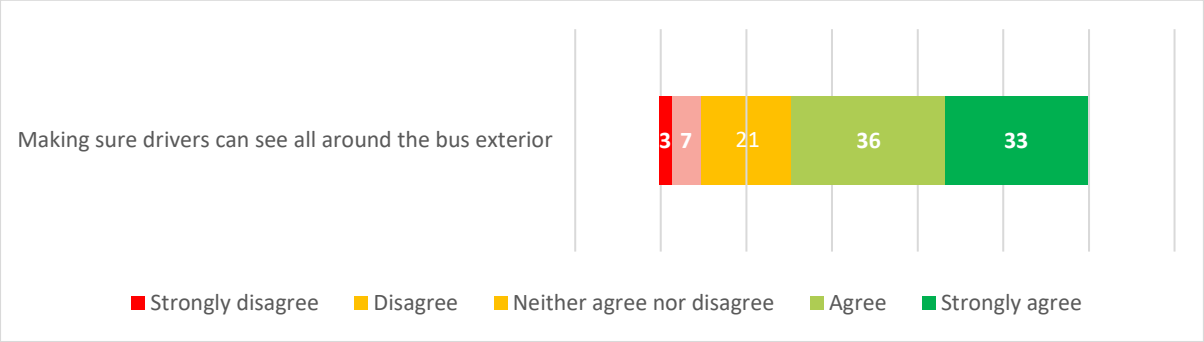
Visual driver aids such as:

- Blind spot mirrors (already fitted)
- Cameras providing external views back to driver replacing the usual wing mirrors with monitors which display view in drivers cabin

NOTE: some operators introduced Camera Monitoring Systems early; they are now a requirement of the BSS 2021 for all new buses.

The drivers who answered the online survey saw this described in a more succinct way using the wording "making sure drivers can see all around the bus exterior", as shown in Figure 6.4.

Figure 6.4 Improved direct/indirect vision: Opinions from the online survey (%)



Base: all respondents (n=593)

69% of respondents (drivers) either strongly agreed or agreed that improved direct/indirect vision would be a suitable solution with an overall ranking of 4 out of the ten suggested solutions.

Opinions of workshop attendees about benefits and limitations of improved direct/indirect vision

Workshop feedback: Most workshop attendees did not agree with a link between improved direct/indirect vision and pedal confusion

Context: Improved direct/indirect vision is designed to avoid driver movement in their cab, maintaining foot position

Topic: Improved direct/indirect vision as a benefit

Some drivers felt it might be a support for more concentration and possibly less distraction. One incident investigator had the opinion that on one occasion driver movement may have been linked to a pedal confusion incident.

Topic: Improved direct/indirect vision as a limitation

Many stakeholders required more clarity around why and how improving direct and indirect vision for a driver would be a suitable solution to reducing pedal confusion and once clarified they remained unconvinced about the link.

A union official held an opinion that if seat position was a key factor, then driver training on this topic would help.

Recommendations for improved direct/indirect vision

Monitor any future pedal confusion incidents and any near misses, with a record of whether the vehicle involved had improved direct/indirect vision and whether there is evidence of driver movement in the cab ahead of the incident or near miss.

Review the importance of correct seat positioning and if required, update as part of the driver training.

Develop driver communications and provide education around the link between driver foot mis-alignment and improved direct/indirect vision

6.2.5 Advanced Emergency Braking (AEB)

Advanced Emergency Braking (AEB) was introduced during the discussions using the text below.

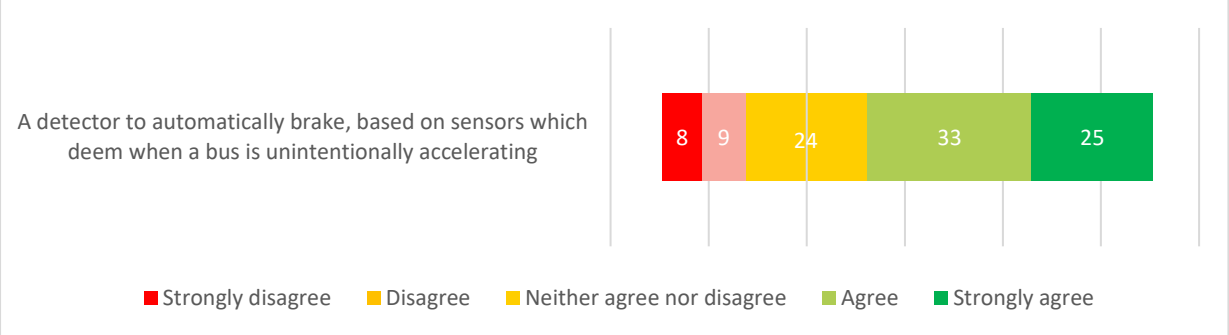
Technology capable of detecting unintended acceleration errors and intervene (e.g. automatic emergency braking interpreting the acceleration signal as a brake signal when a pedal error is detected)

AEB system activation for unintended acceleration scenarios is currently not available on the market but is under development.

NOTE: AEB solutions would be unable to be retrofitted to the current fleet of buses.

The drivers who answered the online survey saw this described in a more succinct way, using the wording “a detector to automatically brake, based on sensors….” as shown in section 6.5.

Figure 6.5 AEB: Opinions from the online survey (%)



Base: all respondents (n=593)

58% of respondents (drivers) either strongly agreed or agreed that AEB would be a suitable solution with an overall ranking of nine out of the ten suggested solutions. However, 58% agreed with the solution, the third highest of the BSS solutions presented in the workshops and the sixth highest overall.

Opinions of workshop attendees about benefits and limitations of advanced emergency braking (AEB)

Main Benefits:	Provides additional support to the driver to reduce or mitigate the chances of human error.
	Reduces the expectation for the driver to react and prevents the pedal application error
Main Limitations:	The parameters the AEB system will need to prevent false activations
	Trust in the technology, especially for drivers
	Time to implement
Context:	Some workshop attendees believed an interim solution would be possible by overriding the driver if too much pressure is put on an accelerator, such as the force used on a brake for an emergency stop.

Topic: Advanced emergency braking as a benefit

While the online survey had a mixed response as a solution to reducing pedal confusion, most of those in the workshops felt Advanced Emergency Braking (AEB) would be beneficial as a solution to reducing pedal confusion.

There were a number of stakeholders holding a view that AEB would reduce the impact of some incidents rather than delivering the solution to avoiding pedal confusion.

Topic: Advanced emergency braking as a limitation

Bus manufacturers had concerns with AEB and felt the solution was high risk and had doubts over the benefit as a solution to reducing pedal confusion. This type of concern was also expressed in the TfL Health and Safety workshop, the Engineers workshop and by union officials

Observation: There's a need to consider instances where a bus driver will need the bus to pick up speed at a junction or as the best course of action to avoid an incident, and the design would need to factor this into the logic.

Observation: The system needs to be able to differentiate between a possible incident and a busy area, with Oxford Street used as an example where this could prove challenging.

Additional discussions in workshops recognised and stated this would be a long term consideration, as technology would need substantial testing before it could be put on the buses and for drivers to be comfortable with the technology being used.

Some drivers felt they'd need reassurance the technology would work before believing it would be a suitable solution to reducing pedal confusion and many stakeholders agreed, caveating their response until they had clarity of the parameters for AEB and how it would work in practice.

Topic: driver reliance on technology

There was a view expressed about the solution encouraging an over-reliance on technology, and reduced driver concentration.

Topic: Interim solution suggested by Engineers, Health and Safety and Operations

There was a belief that a shorter term and more cost-effective solution to pedal confusion similar to AEB was possible by overriding the driver when they apply "too much" pressure to the accelerator, where too much is comparable to the force used when emergency braking, and they believed these solutions would have a similar benefit to AEB as a solution.

Recommendations for advanced emergency braking (AEB)

Build a team of experts to design, validate and test the AEB parameters.

In the interim, assess whether the accelerator pressure solution is viable including a review of when the accelerator is currently pressed e.g., to 100% by drivers.

Establish a clear communication and training guide for buses to build confidence in the final system.

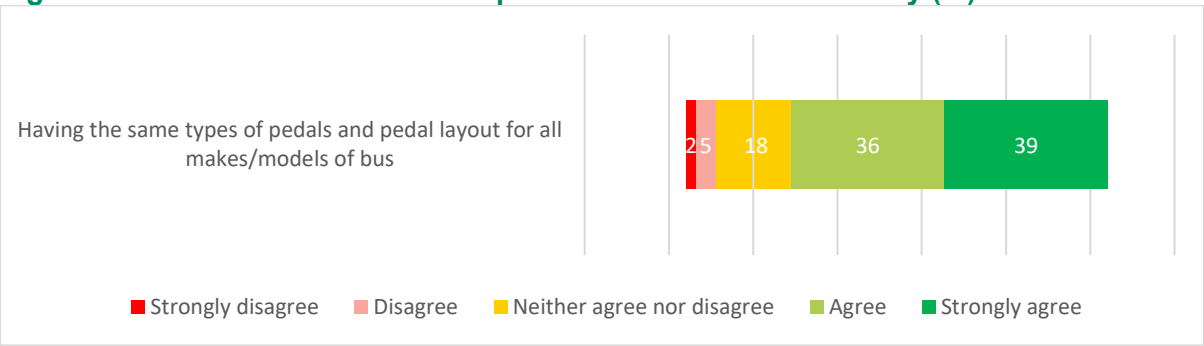
6.2.6 Pedal Standardisation

Pedal Standardisation was introduced during the discussions using the text below.

Propose a standard pedal configuration (pedal location, size, angle, pedal resistance, hanging or floor mounted) for all London buses.

The drivers who answered the online survey saw this described in a more direct way about the same type of pedals and pedal layout for all buses as shown in section 6.6.

Figure 6.6 Pedal Standardisation: Opinions from the online survey (%)



Base: all respondents (n=593)

75% of respondents (drivers) either strongly agreed or agreed that Pedal Standardisation would be a suitable solution with an overall ranking of 3 out of the ten suggested solutions and the highest ranked of the BSS solutions presented in the workshops.
Opinions of workshop attendees about benefits and limitations of Pedal Standardisation

Main Benefits:	Considered to be the most effective
	Driver familiarity as they change bus make and models
Main Limitations:	Design is critical to the success
	Time to implement
Context:	If Pedal Standardisation is included, this needs to be right first time, as stated by Engineers and Health and Safety teams.

Topic: Pedal Standardisation as a benefit

During the workshops, the majority liked this solution, and many described this as the best solution out of the six to help reduce pedal confusion.

Many of the workshop attendees saw the benefits to having a standard pedal arrangement across all London buses, reducing unfamiliarity with pedal setup as drivers move between different models or types of buses during a shift.

Drivers identified as ‘spares’ were one group who other drivers felt would benefit from Pedal Standardisation.

Drivers felt that there was little time to familiarise themselves with the pedals but if they were all standard this would be beneficial and possibly reduce pedal confusion.

Topic: Considerations for Pedal Standardisation

The type, shape and layout of the pedals was a topic that provided different opinions. Workshop attendees agreed there needs to be differences between the pedals in order for drivers to feel the difference in terms of shape, size and feel on the foot. A definitive space between pedals, height of pedals and type of pedals was not agreed upon, although engineers, health and safety and operations experts all concurred that further data and evidence was required before any opinion could be actioned

To summarise, there was general agreement that more work was required to determine what Pedal Standardisation looks like, however there was general agreement that drivers needed to move their feet rather than have the ability to swivel their foot when switching pedals.

It was suggested to look at pedal configurations on bus makes and models which have, and have never, had a pedal confusion incident for any learnings.

Topic: Pedal pressure

One engineer noted there needs to be a change in the amount of pressure that a driver needs to apply for each pedal and suggested it should require more force to press the accelerator and comparatively less force for the brake pedal.

Topic: Limitations of Pedal Standardisation as a solution

While some drivers and stakeholders agreed that this solution could help to reduce pedal confusion, there are still some limitations as respondents also pointed out that this would not solve everything. By standardising the pedal shape, location or size, this does not account for the variability between drivers such as leg length, feet size, shoe grip/resistance and chosen comfortable seating position. These all differ between drivers and therefore will always provide variability in how the drivers position themselves around the pedals.

Whilst overall this solution was preferred by most attendees, there were concerns with the implementation time of this solution with the expectation that this would be implemented as new buses are added to fleets.

Topic: International Organisation for Standards (ISO)

Manufacturers added that all buses are produced in line with the standards set out by the International Organisation for Standards (ISO) and therefore to move Pedal Standardisation forward the ISO standard may need to be reviewed.

Manufacturers agreed that differences in a driver's physique are not a specific consideration and referenced the ISO standards they work to.

Topic: Pedal Standardisation is a contributor to the solution, not a stand-alone solution

Operators also pointed out that a limitation to this is that you can standardise the pedal configuration but on its own, it is not enough. It is also about educating the drivers to drive correctly e.g. keeping their foot over a pedal and not resting it on the floor, regardless of what the vehicle is doing and that education and training needs to be as important as the pedal configuration standardisation.

Topic: Cab design

Manufacturers felt that it wasn't only Pedal Standardisation but also features need to be considered such as seat and steering column position for driver alignment to the steering wheel.

Drivers were keen to explain that to move forward with this solution they felt they should be involved in the design discussion as they have the day-to-day experience and knowledge of the practicalities and would be the end users. Union officials and representatives suggested the same.

Topic: Training

Driver trainers expressed the need for driver training once standardised pedal configuration has been agreed, tested and implemented.

Recommendations for Pedal Standardisation

Conduct an audit of the pedal configuration of each make and model of bus, including but not limited to pedal type, spacing between pedals, pedal height and difference in height between pedals and tread wear.

Carry out analysis of the pedal configuration of each of the 143 buses involved in pedal confusion incident. Identify if there are any similarities or any specific parts to the pedal configuration which never appear; and from this form a view whether it is possible to conclude a link.

Form a working group to consider what Pedal Standardisation would look like, assessing the pros and cons of each and formulating a plan to deliver from concept to implementation.

As part of the working group, identify where drivers and driver trainers can be included.

As part of the working group, identify if the design should go further than pedal, to include other parts of the cab.

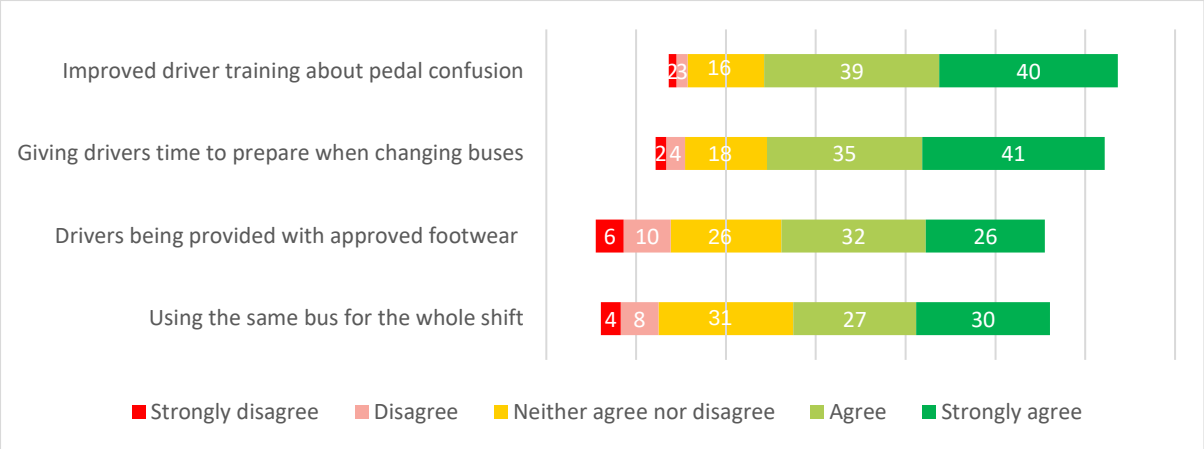
Engage with bus manufacturers to review the ISO standard.

Investigate whether the “spare” drivers have been involved in pedal confusion incidents, near misses (may include other incidents) and whether this is due to driving many makes and models with different pedal layouts

6.3 Other suggested solutions: Online survey

Prior to introducing the BSS solutions, drivers and stakeholders in the workshops were asked for their unprompted opinions on suggested solutions, while drivers who participated in the survey gave their opinions about four other solutions as shown in Figure 6.7.

Figure 6.7 Other solutions: Opinions from the online survey (%)



Base: all respondents (n=593)

Using the same bus for the whole shift

As shown in Figure 3.3 earlier in the report, 86% of those who currently drive a bus stated they typically drive more than one bus per shift, even if it's the same make and model.

Time to change a bus

In the survey, 71% of those who currently drive a bus (n=567) stated they have 5 minutes or less when changing buses.

Those who strongly agreed that giving drivers time to prepare when changing buses was a suitable solution were asked for their view of the length of time to change buses, with the outcomes shown in Table 6.2.

Table 6.2 Suggested mean, median and mode times to change buses by drivers

Average calculated	Time in minutes
Mean	8.8
Median	7
Mode*	5

Base: all respondents (n=241)

*While most drivers (n=80) stated 5 minutes, the second highest (n=62) stated 10 minutes.

Driver training

In the survey, 86% of those who currently drive a bus (n=567) stated they typically drive more than one bus per shift, even if it's the same make and model.

Footwear

Drivers who have experienced pedal confusion are more likely to strongly agree that using approved footwear is a possible solution to pedal confusion compared with those who have not experienced pedal confusion (29% and 19% respectively).

Recommendations

*Drivers trained for correct use of pedals and not swivelling the foot, using the current new driver training as a base for this.

*Review whether footwear has a link to pedal confusion incidents or near misses by reviewing current evidence. If a link is found, further work on footwear requirements should follow.

Validate drivers' opinions from the survey that 86% drive more than one bus per shift, monitor if there is any link between pedal confusion incidents and drivers changing buses and create an action plan if there is data evidence of a link.

*These recommendations are already included in the report and shown again for clarity.

6.4 Other suggested solutions: Workshops

Cut-off switch

Several workshop attendees referenced other modes of transport such as trains and trams who have an engine cut off switch often referred to as a "dead man's switch" which could mitigate the impact of pedal confusion incidents. It was recognised this may not be a solution to prevent pedal confusion but, they felt it would support in incidents where a driver is convinced, they are pressing the brake, but the bus isn't stopping.

Learning from other industries

A number of attendees to workshops asked whether pedal confusion occurs in similar types of vehicles, such as HGVs and coaches. It was acknowledged by attendees that the driving requirements and style were different, such as HGVs do not have passengers and coaches do not have the same number of start/stop procedures that a bus has.

The waste industry was referenced as having a similar start/stop in London streets and may warrant further investigation, with the only major difference being the absence of passengers.

Reducing driver pressure and fatigue

In the majority of the workshops, TfL, Operator, Unions and Drivers expressed their view that drivers working under pressure or having other distractions from passengers and other road users, are potential contributory factors in pedal confusion incidents There was a belief that reducing pressure on drivers including time between shifts (fatigue) would reduce pedal confusion.

As referenced in section 1.7 of this report, a separate report TfL has previously commissioned Loughborough University to complete a study in to bus driver fatigue[5].

[5] https://content.tfl.gov.uk/bus-driver-fatigue-report.pdf

Recommendations

Use a working group to verify if the opinions of engineers, health and safety and operations teams are correct and a cut-off switch when too much pressure is placed on the accelerator will have an impact, can be implemented and will be safe.

Investigate if there are any learnings from other industries, specifically:

- Contact the International Bus Benchmarking Group (IBBG) and members for learnings about pedal confusion incidents (if any) from the international industry and if there is appetite for holding a discussion group to build cross-industry best practice to avoid pedal confusion incidents (see chapter 2)
- Similar to the IBBG, contact bus operators, for example, incident investigators, for a national view, starting in busy UK cities to understand whether these types of incidents occur, how they categorise the incidents and take learnings from any successful solutions.
- Contact other UK industries who drive regularly in London, as a minimum, contact the waste industry.

As recommended in Chapter 5, identify whether there is a link between driver fatigue and pedal confusion with links to the Loughborough University report.

7. Recommendations

This chapter sets out our recommendations arising from this research study. We have not been able to evaluate the potential effectiveness of the recommendations, therefore these actions are not a prioritised list.

All recommendations are based on the opinions provided in the survey and workshops, as explained in earlier chapters, these opinions are not evidence led, therefore, the recommendations are formed from the analysis of these opinions and not evidence.

7.1 Summary of recommendations

Throughout the report, recommendations have been made and the following tables summarise these recommendations. Each recommendation has received a score from 1 to 3 for each of cost, time and value, where 1 is low and 3 is high.

Cost indicator:

Cost assumption compared with other recommendations

£	May be achieved with little or no additional employee time or outlay for technology
£ £	Requires some investment in technology and/or additional employee time
£ £ £	Requires highest investment in technology, and/or additional employee time or additional employees

Time indicator:

Time assumption compared with other recommendations

🕓	Short term: Less than one year
🕓🕓	Medium term: 1 to 3 years
🕓🕓🕓	Long term: 3+ years

Value indicator:

Possible contribution as a solution to pedal confusion (guidance only)

✪	Marginal impact, more indirect and less direct impact
✪✪	Medium impact: possibly offer some direct impact
✪✪✪	Largest impact: possibly offer most directly impact

The ratings in each table should only be used as a guide and AECOM do not accept any responsibility for how this guidance is used.

Each recommendation includes a suggested “owner” of the task, again, this is for guidance and it is anticipated that TfL and bus operators would need to work collaboratively on all tasks.

Main recommendation

The main recommendation of this report is the need to gather evidence to validate each recommendation in the table below and the impact it will have to the reduction of pedal confusion incidents.

Table 7.1 shows recommendations to improve the type of data collected and analysis of all data. Using the TfL Safe Systems model, these recommendations fall under the **Post Collision Response** pillar.

Table 7.1 Post Collision Response: Understanding causes through data collection and analysis

Recommendation	Owner	Cost	Time	Value
Comprehensive review of the IRIS database: Expand the number of data fields, including adding an incident category for suspected pedal confusion, vehicle make and model, engine type (electric/hybrid/diesel) and which BSS solutions were installed.	**TfL / Bus operators**	£	🕓	✪✪
IRIS database accuracy improvement: Force all fields for data entry to be comprehensive and provide guidance on how to complete entries to ensure all key data is captured.	**TfL**	£	🕓	✪
Traffic flow: Explore measuring traffic flow prior to the incident to establish any abnormalities on the day of the incident.	**TfL / Bus operators**	£	🕓	✪
Road layout and other external factors: Record of the road layout, traffic flow procedures (e.g. traffic lights); number of lanes, any joining or additional lanes, bus lane available. A full list to be defined by TfL and bus operator experts.	**TfL / Bus operators**	£	🕓	✪
Introduce footwell cameras on all buses: Use for driver training and improvement for prevention as well as incident investigation.	**Bus operators**	£	🕓🕓	✪✪
Pedal configuration: Carry out analysis of the pedal configuration such as but not limited to, pedal spacing, height differential, pedal type (organ or hanging) for each of the 143 incidents that have been reported from 2015 to 2019 and any incidents since 2019 and report prior to any Pedal Standardisation proposal is implemented.	**TfL / Bus operators**	£	🕓🕓	✪✪
Improve driver reporting culture: Build an open culture with drivers to report near-misses to their operators and operators to TfL.	**TfL / Bus operators**	£	🕓	✪

Tables 7.21 and 7.22 show recommendations to understand the main possible causes of pedal confusion. Using the TfL Safe Systems model, Table 7.21 shows recommendations that fall under the **Safe Behaviours** pillar and Table 7.22 shows those that fall under the **Safe Vehicles** pillar.

Table 7.21 Safe Behaviours: Understanding the main possible causes of pedal confusion

Recommendation	Owner	Cost	Time	Value
Driver communication: Review the iBus controllers communication procedures with drivers, compare these with the Big Red Book to build best practice.	**TfL / Bus operators**	£	🕓	✪
Driver training: Ensure drivers are receiving training for correct use of pedals (not swivelling foot) and consider if refresher or targeted training on pedal confusion can be provided.	**Bus operators**	£	🕓	✪
Possible cause review: Driver fatigue Consider whether driver fatigue and different pressure points drivers' experience has an impact on stress and possible loss of concentration.	**TfL / Bus operators**	£	🕓🕓	✪✪
Possible cause follow-up: Driver fatigue Investigate if any solutions to driver fatigue, as provided in the fatigue report, will reduce pedal confusion incidents or has reduced incidents once implemented	**TfL / Bus operators**	£ £	🕓🕓	✪✪
Possible cause review: 'Spare' drivers Investigate if 'spare' drivers, who regularly change buses are more likely to be involved in pedal confusion incidents or near misses.	**Bus operators**	£ £	🕓	✪
Possible cause review: Footwear Review whether footwear has a link to pedal confusion incidents or near misses by reviewing current evidence. If a link is found, further work on footwear requirements should follow, and any testing and trials would potentially add time and cost	**TfL / Bus operators**	£	🕓	✪

Table 7.22 Safe Vehicles: Understanding the main possible causes of pedal confusion

Recommendation	Owner	Cost	Time	Value
Pedal differential analysis: Explore differentials across bus make and model for pedal type, height, and spacing by conducting an audit of the current fleet.	**TfL / Bus operators**	£	🕒	✪
Possible cause review: Traffic and speed Conduct further analysis to understand whether travel at slow speed and/or heavy traffic is a contributory factor and if so, add further workstreams such as driver training	**TfL**	£ £	🕒	✪ ✪
Possible cause review: Brake regeneration Conduct further analysis to measure brake regeneration in hybrid and electric buses as a possible cause using current data and/or track tests with drivers.	**TfL**	£ £	🕒 🕒	✪ ✪
Possible cause review: Acceleration rates Measure if the assumed difference in acceleration between electric, hybrid and diesel buses is shown in driver data and if so, further investigate how this could be mitigated for when considering pedal confusion	**TfL / Bus operators**	£	🕒	✪ ✪

Tables 7.31, 7.32 and 7.33 shows recommendations to understand the potential of possible solutions to pedal confusion. Using the TfL Safe Systems model, Table 7.31 shows recommendations that fall under the **Post Collision Response** pillar, Table 7.32 shows those that fall under the **Safe Behaviours** pillar and Table 7.33 shows those that full under the **Safe Vehicles** pillar.

Table 7.31 Post Collision Response: Understanding the main possible solutions to pedal confusion

Recommendation	Owner	Cost	Time	Value
BSS introduction of brake toggling: Measure if buses with brake toggling are involved in less incidents; include near-miss data.	**TfL**	£	🕒 🕒 🕒	✪ ✪

Table 7.32 Safe Behaviours: Understanding the main possible solutions to pedal confusion

Recommendation	Owner	Cost	Time	Value
Improved direct/indirect vision: Monitor any evidence that driver movement has been a contributory factor to pedal confusion. If confirmed, share evidence with relevant TfL and Operators teams.	**TfL / Bus Operators**	£	🕒 🕒	✪
Improved direct/indirect vision: If monitoring shows a link to pedal confusion, update driver training and education	**Bus Operators**	£	🕒 🕒	✪ ✪

Table 7.33 Safe Vehicles: Understanding the main possible solutions to pedal confusion

Recommendation	Owner	Cost	Time	Value
Technology review: Build a library of lessons learnt from current technology such as early warning systems.	**TfL**	£ £	🕒 🕒	✪ ✪
Pedal Acoustic Feedback: Use learnings from AVAS to develop a sound, engage with bus drivers for buy-in; Produce a multi-beneficial sound such as improving driving style.	**TfL / Bus Operators**	£ £	🕒 🕒	✪ ✪
Advance Emergency Braking (AEB): Consider building a team of experts to design, validate and test the AEB parameters and to cover training and implementation once approved.	**TfL / Bus Operators**	£ £ £	🕒 🕒 🕒	✪ ✪ ✪
Accelerator pressure interim solution: Consider building an expert development team to assess whether an accelerator pressure solution is viable including a review of when the accelerator is currently pressed hard by drivers e.g. to 100% and possible safety implications of applying an interim solution.	**TfL / Bus Operators**	£	🕒 🕒	✪ ✪
Pedal Standardisation: Engage with bus manufacturers for a possible review of the ISO standard for pedal layout, for example pedal types, height, width and spacing.	**TfL**	£	🕒 🕒	✪ ✪
Pedal Standardisation: Build an expert working group to assess what standardisation could look like with pros and cons. Use findings from the analysis of the 143 incidents suggested for further evidence.	**TfL / Bus Operators**	£	🕒 🕒	✪ ✪
Pedal Standardisation: Consider whether Pedal Standardisation should expand to cab standardisation.	**TfL**	£ £	🕒 🕒	✪
Introducing a throttle kill switch: A similar to the system used by the railway. Investigate whether adding a throttle kill switch to shut off power to the engine will achieve either or both of, preventing a more serious incident during pedal confusion or improving safety when recovering a vehicle following an incident.	**TfL**	£	🕒	✪ ✪

Table 7.4 shows recommendations to gain any learnings from peer groups. Using the TfL Safe Systems model, these recommendations fall under the **Post Collision Response** pillar.

Table 7.4 Post Collision Response: Learnings from peer groups and other industries

Recommendation	Owner	Cost	Time	Value
International peer groups: Contact the IBBG for learnings from the international industry and if there is appetite for a forum for best practice and solutions	**TfL**	£	🕒🕒	✪✪
National peer groups: Work with bus operators to build a national view of pedal confusion for the UK and if similar incidents happen elsewhere and how these are recorded	**TfL / Bus Operators**	£	🕒	✪✪
Other industries: Contact other UK industries, starting with waste disposal, investigate if pedal confusion incidents occur in their industry. Either way, analyse similarities and differences between the industries, assess if conclusions can be reached.	**TfL**	£	🕒🕒	✪✪

Additional Recommendation: For solutions already introduced as part of the Bus Safety Standard (BSS)

This report acknowledges that some of the solutions presented in the workshop have been introduced on new buses in the fleet, as per the BSS roadmap. A final recommendation is for all future incident investigations linked to possible pedal confusion to report:

1. Which of the solutions, if any, were a feature of the bus;
2. If the solution has been introduced, record any mitigating circumstances to explain why the solution was unable to prevent the incident from occurring; and
3. If the solution had not been introduced but was a requirement of BSS, ascertain why the solution is not in situ and whether, in the opinion of the incident investigator, if the solution would have been introduced as required could it have prevented the incident or reduced its impact.

Appendix A Literature review titles

1. **Human Engineering Limited.** *Identifying Solutions to Pedal Confusion in Buses.* London : Transport for London, 2011. HEL/TfL/102561/RT01.

2. **Transport Research Laboratory Limited.** *The Transport for London Bus Safety Standard: Pedal Application Error Prevention & Recovery.* London : Transport for London, 2018. PPR984.

3. **TTN Technologies Ltd.** About Footright. *Footright Safe Pedal Management.* [Online] 2015. [Cited: 13 10 2021.] https://ttntechnologies.wordpress.com/

4. **United States Department of Transportation.** Pedal Application Errors. *National Highway Traffic Safety Administration.* [Online] 03 2012. [Cited: 04 10 2021.] https://www.nhtsa.gov/staticfiles/nti/pdf/811597.pdf

5. **Department for Transport.** Road Safety Data. *Find Open Data.* [Online] 24 September 2021. https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data.

6. **Hasegawa, Kunihiro, Kimura, Motohiro and Takeda, Yuji.** Pedal Misapplication: Interruption Effects and Age-Related Differences. *Human Factors: The Journal of the Human Factors and Ergonomics Society.* [Online] 02 07 2020. [Cited: 01 10 2021.] https://journals.sagepub.com/doi/10.1177/0018720820936122.

7. **Department for Transport.** Road Safety Data. *Find Open Data.* [Online] 24 September 2021. https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data

In addition, the International Bus Benchmarking Group provided a members report in confidence:

Clearinghouse Study: Fatal Injuries. **Dublin Bus.** London, 2007.

Appendix B Example communications poster

The poster shown below is an example sent to Abellio drivers, each operator received their own branded communication, supported by TfL and the relevant bus Operator communications teams.

July 2021

Sharing your views - Pedal confusion

busdriversurvey.com

Bus Drivers

Through London's Vision Zero, TfL aim to have a 70% reduction in the number of people seriously injured or killed by buses by 2022. To help, AECOM have been asked to learn about pedal confusion from drivers and their colleagues.

A survey has been produced to collect your views to share anonymously with TfL. This will be open until Monday 9 August and takes about 10 minutes to complete.

- Take this survey on mobile, tablet or PC
- Type in the link busdriversurvey.com
- Scan the QR code

What's in it for you?
An opportunity to share your views to avoid more incidents.
Win **£100** in Amazon vouchers; plus **two £50** runner-up prizes

£50 amazon.com Gift Card

Confidentiality Assured:

Only anonymous results are provided to TfL and Abellio. AECOM is an independent consultant who will receive your answers directly and produce a summary report of the overall findings. AECOM are bound by UK Data Protection Law (was GDPR) and are members of the Market Research Society.

Have more to say on this? busdrivergroup.com

Would you like to share your experience to help us find solutions? We would like to hear more from you and be one of five drivers taking part in a 90-minute group discussion. Sessions will take place between Monday 2 August - Friday 20 August.

A **£50** amazon voucher will be offered to cover your time (email address required).

Location: Face-to-face in your garage or online discussion groups, at home.

If you are interested in taking part, please enter your contact details, using the link: busdrivergroup.com or call 0800 652 8646. AECOM will be in contact with you.

2 July 2021

abellio AECOM Transport for London BUSES

Appendix C Online Questionnaire

Introduction
On behalf of Transport for London (TfL), AECOM; an independent research consultancy, is carrying out research about the occurrence of pedal confusion when buses are being driven.

The survey will take around 10 minutes**.**

We're aware of the sensitivity of this subject and we are keen that when you answer this survey you feel able to do so while being assured and confident that your responses are kept confidential.

Pedal confusion can lead to serious incidents and even fatalities which is why it is so important to get your honest views in this survey, to help TfL, bus operators and bus drivers in their bid to prevent it occurring in the future.

Your anonymity and using the answers you provide
We have taken steps to maintain the anonymity of your answers by:

1. Not sharing individual responses with TfL; and
2. Only providing a combined set of answers to TfL in a report format.

Your rights and our reassurance to you
The survey is being carried out under the Market Research Society's Code of Conduct. A copy of this is available here: mrs.org.uk/standards/code-of-conduct. The principles of this code of conduct include:

- Be transparent as to the subject and purpose of data collection.
- Respect the confidentiality of information collected in their professional activities.
- Respect the rights and well-being of all individuals.

You can access the AECOM's privacy policy using this website: aecom.com/privacy-policy/. To exercise all relevant rights or if you wish to make a query or file a complaint, in the first instance please contact AECOM's Data Protection Officer at privacyquestions@aecom.com. You can also contact the Information Commissioner's Office on 0303 123 1113 or via email ico.org.uk/global/contact-us/email/ or at the Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire. SK9 5AF.

ASK ALL
SINGLE CODE

1. Which bus operator do you work for?

Abellio
Arriva
HCT Group
Go-Ahead
Metroline
RATP Dev
Stagecoach London
Sullivan Buses
Tower Transit
Uno

ASK ALL
SINGLE CODE

2. Which of the following best describes your job role?

i. Bus driver
ii. Bus driver trainer
iii. Bus depot manager
iv. Health and Safety manager
v. Engineer
vi. Engineering Manager
vii. Work in an office role at the bus depot not directly with buses
viii. Other (please specify)

ASK ALL BUS DRIVERS (Q2=1)
SINGLE CODE

3. How long have you worked in total as a bus driver?

One year or less
Between one and three years
Between three and five years
Between five and 10 years
Over 10 years

ASK Q2=CODE 2,3,4,5,6,7,8
SINGLE CODE

4. Before your current role had you ever worked as a bus driver?

Yes
No

ASK Q4=CODE 1 (YES), previously worked as a bus driver
SINGLE CODE

5. How long did you work as a bus driver?

One year or less
Between one and three years
Between three and five years
Between five and 10 years
Over 10 years

ASK ALL
SINGLE CODE
ASK IF ALREADY KNOW TIME AS BUS DRIVER (AT Q3 OR Q5)

6. How long have you worked in the bus industry?

One year or less
Between one and three years
Between three and five years
Between five and 10 years
Over 10 years

ASK ALL DRIVERS (Q2=1)
SINGLE CODE

7. Typically, how many different buses do you drive in one shift, even if it's the same make/model of bus?

1
2
3
Over 4 (please specify)

ASK DRIVERS WHO DRIVE MORE THAN ONE BUS PER SHIFT (Q7=2,3 OR OVER 4)
SINGLE CODE

8. Typically, how many different makes/models of bus do you drive in one shift?

1
2
3
Over 4 (please specify)

ASK ALL DRIVERS AND THOSE WHO USED TO DRIVE (Q2=1 or Q4=1)
MULTICODE

8a Which of these makes of bus do you drive or have you driven in the past? Please select all that apply

ADL
BYD
Caetano
MCV
Mercedes Citaro
Optare
Scania
Wrightbus
Other (please specify)

ASK IF Q7=MORE THAN ONE BUS IN ONE SHIFT (Q7=2,3 OR OVER 4)
SINGLE CODE

9. When changing buses, typically how much time do you take from your bus arriving until you drive it away?

5 minutes or less
More than 5, up to 10 minutes
More than 10, up to 15 minutes
Over 15 minutes

ASK ALL
INTRO TEXT:
We would like to ask some questions about the potential for pedal confusion to occur when a bus is being driven. We'd like to reiterate that your responses are anonymous and the answers to this questionnaire will only be reported as a combined set of responses.

The definition of pedal confusion we are using is:
Pedal confusion is defined as an occurrence of a driver accidentally selecting the brake pedal instead of the accelerator pedal or the other way around. This causes either sudden unintended acceleration or harsh braking. This may lead to incidents such as a collision outside the vehicle, passengers being jolted inside the vehicle or may have no impact at all such as a near miss as the driver successfully recovered the situation.

ASK ALL
SINGLE CODE
10. How frequently do you believe pedal confusion occurs amongst London bus drivers even if there isn't a collision?
Select one only

i. At least once a week
ii. Less than weekly but at least once a month
iii. Less than once a month but at least once every 3 months
iv. Less than once every 3 months but at least once every 6 months
v. Less than once every 6 months but at least once a year
vi. Less than once a year but it does happen
vii. I'm not aware of this ever happening
viii. Prefer not to say
ix. Don't know

SHOW TO ALL
Bus operator incident data shows there have been **at least** 43 incidents where pedal confusion contributed to an incident between 2002 and 2018. Two of these had a fatality.

ASK ALL DRIVERS OR FORMER DRIVERS (Q2=1) or (Q4=1)
SINGLE CODE
11. Have you ever received training about pedal confusion, either when you joined the company or since?

Yes
No
Don't know / Can't remember

ASK ALL
SINGLE CODE
12. At what point in a journey do you think pedal confusion is most likely to occur?
Setting off from a depot
Setting off from a bus stop
At a junction, setting off
At a junction, slowing down
Slowing down for a bus stop
Driving back into a depot
Other (please specify)
Don't know

ASK ALL
SINGLE CODE
13. At what point in a shift do you think pedal confusion is most likely to occur?
At the start of a shift
Just before a break
Just after a break
Near the end of the shift
At any time a driver changes buses
At any point in the shift, the time isn't a factor
Other (please specify)
Don't know

ASK ALL EXCEPT DON'T KNOW AT Q12 AND Q13
OPEN END: 9999 CHARACTERS
14. When asked about when pedal confusion is most likely to occur, why did you say (PIPE FROM Q12) during a journey and;
Why did you say (PIPE FROM Q13) for the part of the shift?

ASK ALL
TOP 3
ROTATE LIST
15. Which of the list below do you believe are the main factors that lead to pedal confusion?
Please select the top three factors.
Switching from one bus to another, even if it's the same make/model
Passengers distracting the driver inside the bus
Pedestrians distracting the driver outside the bus
Other road users distracting the driver
A driver's mind wandering and losing concentration
At blind spots where a driver may concentrate on making sure they don't hit anything or anyone
At traffic lights / road junctions where other road users move in front of buses
At bus stops when other road vehicles do not let buses out
Driving in heavy traffic (stop/start)
Driving when dark
Driving a night bus
Driver fatigue
Human error
Drivers not being able to hear when the bus is accelerating

ASK ALL
OPEN END
16. Do you think there are any other reasons which are not listed which may lead to pedal confusion?

ASK ALL
MULTI CODE
17. What experience do you have of pedal confusion? Please select all that apply
I've experienced pedal confusion myself
I'm aware of pedal confusion happening to other drivers
I know what it is but do not know of any experiences
I do not have any knowledge of pedal confusion **EXCLUSIVE**

ASK IF Q17=CODE 1
MULTI CODE
18. What is your personal experience of pedal confusion?
Using the accelerator instead of the brake
Using the brake instead of the accelerator
I've used both the accelerator instead of the brake and brake instead of the accelerator
Other (please specify)

ASK IF Q17=CODE 1
SINGLE CODE
19. What type of vehicle were you driving?
Petrol
Diesel
Hybrid
Electric
Don't know / Can't remember

ASK IF Q17=CODE 1
MULTI CODE
20. Can you recall the make and / or model of the vehicle you were driving?
Yes
No

ASK IF Q20=CODE 1
OPEN BOXES X 2
21. Please provide the make and model
MAKE: MODEL:

ASK IF Q17=CODE 1
OPEN BOX NUMBER MAX 2 DIGITS
22. How many times have you experienced pedal confusion in the past year?

ASK IF Q17=CODE 1
OPEN BOX NUMBER MAX 2 DIGITS
23. How many times has the pedal confusion led to a collision in the past year?

ASK IF Q17=CODE 2
MULTI CODE
24. What is your knowledge of the occasions when another driver described pedal confusion?
Please select all that apply

The driver used the accelerator instead of the brake
The driver used the brake instead of the accelerator
Other (please specify)
Don't know the details **EXCLUSIVE**

ASK IF Q17=CODE 2 (NUM BOX, MAX 3 NUMBERS)
25. How many different drivers have mentioned they've experienced pedal confusion in the past year?

ASK IF Q17=CODE 2
MULTI CODE

26. What was the outcome of the incident(s)?

Please select all that apply

There has been a collision which involved another person (including cyclists/car drivers)
There has been a collision which involved an object (e.g. a tree or lamp post) but not a person
Passengers were jolted, but no outside collision
There was a near miss as driver successfully recovered the situation, no collision and passengers unaffected
Other (please specify)

ASK IF Q17=CODE 2
OPEN BOX NUMBER MAX 2 DIGITS

27. How many times have you heard of drivers experiencing pedal confusion in the past year?

OPEN BOX times

ASK IF Q17=CODE 2
OPEN BOX NUMBER MAX 2 DIGITS

28. How many times have these pedal confusion incidents led to a collision in the past year?

OPEN BOX times

ASK ALL BUS DRIVERS
SINGLE CODE

29. To what extent do you agree with the statement:

I have been trained to recognise when unintended acceleration is occurring and how to respond to it

Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

ASK ALL BUS DRIVERS
SINGLE CODE

30. How frequently do you choose to "coast" while in control of the bus?

Very frequently (multiple times on a route)
Frequently (at least once on a route)
Occasionally
Rarely
Never

ASK IF COAST FREQUENTLY (Q30=1 OR 2 OR 3)
MULTI CODE

31. Which of these places are you most likely to "coast"?

Please select all that apply

Sitting in slow moving traffic
Once I'm up to speed and I see traffic stopped ahead
Arriving at a bus stop
Arriving at the depot
Other (please specify)

ASK ALL
SINGLE CODE PER ROW
ROTATE OR RANDOMISE LIST

32. To what extent do you agree or disagree that the following possible solutions would reduce pedal confusion amongst bus drivers?

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	Don't Know
Forcing a driver to apply the brake pedal before engaging a gear to drive away (e.g. when leaving the depot or bus stop)	1	2	3	4	5	6
Having the same types of pedals and pedal layout for all makes/models of bus	1	2	3	4	5	6
Making sure drivers can see all around the exterior of the bus before setting off, i.e. no more blind spots	1	2	3	4	5	6
Having an audible cue to inform the driver when the bus is accelerating from a low speed or stationary position	1	2	3	4	5	6
Having a visible cue, such as a light, to inform the driver when the accelerator and brake pedal are being pressed	1	2	3	4	5	6
A detector to automatically brake, based on sensors which deem when a bus is likely to be unintentionally accelerating	1	2	3	4	5	6
Drivers being provided with approved footwear to be used when driving buses	1	2	3	4	5	6
Giving drivers time to prepare when changing buses	1	2	3	4	5	6
Using the same bus for the whole shift	1	2	3	4	5	6
Improved driver training about pedal confusion	1	2	3	4	5	6

ASK IF GIVING DRIVER TIME TO PREPARE IS STRONGLY AGREE OR AGREE
OPEN MAX 2 NUMBERS

33. You agreed that giving drivers time would be a possible solution to reduce pedal confusion. How long, in minutes, do you think should be given to a driver to prepare before driving away safely?

OPEN BOX Minutes

ASK ALL
DO NOT FORCE
QPRIZE
Thank you for taking the time to complete this survey.

To enter you in to the prize draw we need you to provide contact details to reach you should you win a prize, you can include either a phone number or email address or both.

If you do not want to provide these details please select next to move on to the next page however we will not be able to include you in the prize draw.

Your contact details are only used for the prize draw and they are separated from your answers straight away. Neither TfL or your bus operator will receive these details.

Q34 – Q36
Name
Phone number **NUMERIC AND VALIDATE**
Email address **VALIDATE**

ASK ALL BUS DRIVERS (Q2=1)
SINGLE CODE
QGROUP
We are keen to hear more about your views on pedal confusion and specifically about solutions which are being proposed.
AECOM are running some group discussions with bus drivers which would last 90 minutes each. These will occur outside your working hours and for that reason we would include an Amazon voucher of £50 to all those who attend in return for their time.
These discussions will be with up to 4 other drivers (expect 5 in a group) and other than these drivers nobody else from TfL or your bus operator will be present.
The groups discussions will be recorded on the day, again, these are for AECOM's analysis reasons only and the recordings will not be shared with TfL or your operator and everything you say will be kept anonymous.
Q37 If you wish to attend a group discussion please confirm below. We will contact you at a later date to make specific arrangements:

- Yes: I would like to be involved in the group discussions and you can use the contact details that I have provided for the prize draw to contact me
- Yes: I would like to be involved in the group discussions but I did not leave my contact details or I would like to give you different details
- No: I do not wish to attend a group discussion
- Don't Know: I need to decide later.

ASK IF QGROUP=YES BUT NEEDS TO GIVE CONTACT DETAILS (CODE 2)
TEXT
QCONTACT
Please provide a phone number or email address or both to enable us to contact you. If you do not want to provide these details please select next to move on to the next page however we will not be able to include you in the group discussions.

The contact details you give are for AECOM to make arrangements with you for attending the groups and for this reason only, these details are stored separately from your answers.

Q38 – Q40 Neither TfL or your bus operator will receive these details.
Name
Phone number **NUMERIC AND VALIDATE**
Email address **VALIDATE**

ASK ALL WHO SAID YES TO A GROUP (QGROUP=1 OR 2)
SINGLE CODE
QLOCATION
There are two options for holding the groups,

ONLINE (INTERNET): If most drivers prefer to complete these from home using the internet, we will arrange for these to be completed online. To use the internet you need to have a tablet, laptop or PC with a webcam (i.e. in the same way you use for Zoom calls, Facetiming etc).

OFFLINE (FACE-TO-FACE) We can arrange for a face-to-face discussion to take place in a depot close to you (it may not be your main depot) with somebody from AECOM in attendance.

Q41 Please give your preferred method for the group discussions
If you have no preference and have a webcam at home please select the bottom option
Online (using the internet and I confirm I have a webcam at home
Face-to-face in a meeting room
I don't mind and I confirm I have a webcam at home.

ASK IF QGROUP=DON'T KNOW (CODE 4)
TEXT
QDON'T KNOW
If, at a later date, you decide you would like to attend a group, please type Busdrivergroup.com in your internet browser and there will be a short survey asking for your contact details and we will then be in touch. You can find this web address on the communication from your operator.
Please select next to continue
ASK ALL
TEXT
Thank you again.
Please click on the submit button below to upload your answers and close your survey.

Appendix D Workshop Discussion Guide

The same discussion guide was used for all, with the exception of the introductions where workshop attendees included the name of the operator they were representing (or TfL) and driver discussion attendees included their years of experience and make(s) of bus they frequently drive.

Introduction session

Format of the session (adapt if online)

- H&S – Fire exits, toilets, refreshments, no mobile phones
- Introduce moderator / note taker and on behalf of TfL
- Recording the groups – Only for internal use etc. Comments and findings are anonymised
- No right or wrong answers.
- Collating view from a wide range of stakeholders.
- Objectives for today (reviewing solutions to reduce/remove pedal confusion)
- Don't have to reach a consensus

Introduction AECOM

- Self/ AECOM/independent consultancy
- Conducting research on behalf of Transport for London
- Purpose of research to talk about Pedal Confusion and the solutions to it
- Emphasise there are no right or wrong answers
- Emphasise confidentiality – recording interview for accuracy of reporting. Recording will not be passed on to anyone outside the research team or the client team. Findings are aggregated for reporting. Stress anonymity in reporting of findings

Introduction Respondents

- Introduce themselves
- First name
- Role / Operator
- How long have they been in the bus industry?

5 mins

If the incident at London Victoria is raised where a pedestrian lost their life. The incident is under investigation and the cause is unknown.
This should be mentioned before the discussion gets too deep and then continue with the discussion.

Context

TfL Vision Zero show on Powerpoint for all to read.

- 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
- No one killed in, or by, a London bus by 2030

TfL's aim is to make the whole system as safe as possible so that when a road user, i.e. a cyclist, pedestrian or another driver does make a mistake, this mistake does not result in serious or fatal injury

Pedal confusion

- What is the definition of pedal confusion?
- Not why it happens but what is it?
- After driver discussion agree a definition and share:

Definition of Pedal Confusion

show on Powerpoint for all to read.

Pedal confusion can be defined as the manoeuvre of a driver confusing the brake pedal and the accelerator pedal thus causing an incident of sudden unintended acceleration or harsh braking of their vehicle.

- Is this the right definition of pedal confusion?
- Should we include both unintended acceleration and harsh braking?
- Anything to add…..aim for all to settle on a definition although overall consensus is not required

READ OUT BELOW IF THERE HAS BEEN DOUBT ABOUT WHETHER PEDAL CONFUSION EXISTS:

Bus operator incident data shows there have been **at least** 43 incidents where pedal confusion contributed to an incident between 2002 and 2018. Two of these had a fatality.

Footwell CCTV has shown pedal confusion to be a cause of incidents.

Reference: if asked: Transport Research Laboratory report on the TfL bus safety standard using bus operator incident data

Twitter video or similar

PLAY and put in full screen, short video so repeat 2 to 3 times:
https://twitter.com/howzmeluck/status/1240405171118772227?s=20

- Views on the video:
  - Is this an example of a driver experiencing pedal confusion?
  - How do we know (either way)?
  - What else, other than pedal confusion could have happened?

10 mins

Causes of pedal confusion

What are the potential causes of pedal confusion?

- PROBE: Bus specific
  - How do physical driving features on a bus vary? E.g. seating position, vision, pedals
  - Any makes/models considered better/worse?
  - What physical features of a bus could cause pedal confusion?
    - pedal layout (whether pedals are close together, how visible they are to the driver or how they differentiate between the two pedals; familiarity / unfamiliarity with personal car or other vehicles they drive;
    - bus size / visibility
  - Does engine type make a difference? i.e. diesel, hybrid, electric
  - Different makes/models of bus: any makes better than others in terms of visibility, pedal layout.
  - Changing from one make/model of vehicle to another and changing to another vehicle of the same make/model. How is this different?

  PROBE: is changing vehicles more to do with the physical features of a driver (height, shoe size) than changing make/model and the vehicle layout?
- Driver specific factors to PROBE:
  - What factors could be down to human error?
    - Driver error
    - What leads to driver error (e.g. fatigue, concentration disturbed by passengers)
    - Any manoeuvres which could cause unintended acceleration/harsh braking
- External factors to PROBE:
    - Driver footwear
    - Gears/pedals on a personal car vs on a bus; different types of buses
    - Emergency action avoiding a collision

IMPORTANT TO CHECK,. ESPECIALLY DRIVERS:

Impact of changing to hybrid or electric buses, i.e.

- Any noticeable change in pedal alignment
- Any noticeable change in acceleration / brake pedal i.e. harder or easier to press

If impact of changing buses is mentioned, confirm

MAKE of bus and

TYPE of bus, i.e. hybrid, electric, hydrogen, diesel

10 mins

Timing of incidents

When do you feel these incidents are most likely to happen? PROBE:

- Time of day
- Time of shift (i.e. beginning, middle, end)
- After multiple shifts
- Night bus / driving in the dark / driving in the day
- Peak periods vs off-peak
- Can relaxation after a “difficult” route lead to relaxation and oversight?

5 mins

Pedal configuration and footwear

What do you think of the current pedal configuration in relation to pedal confusion?

PROBE:

- Organ (flat) or hanging type pedals
- Type of tread on the pedals
- Distance between pedals
- Different levels of pedal resistance for different vehicles
- How does variation of pedal alignment for different makes of bus affect drivers? Including changing buses mid-shift

Does the type of footwear drives wear impact recognition of the pedals?

- Can drivers feel the pedals

5 mins

Solutions to pedal confusion

Spontaneous or first thoughts on best solutions

- Can think as far reaching as they feel necessary, assume no limit on budget and anything is possible!
- PROBE: Vehicle related / External (see examples)
    - How can buses be adapted;
    - Anything to allow for external distractions such as vehicles/cyclists/pedestrians completing unexpected manoeuvres
    - Are there any examples of make/model of bus which deliver already? What do they deliver and why?
    - Use of cameras / blind spot mirrors
- PROBE: Driver related (see examples):
    - One vehicle per shift;
    - Time to adjust when changing buses;
    - Driver checklist before setting off, such as confirm correct vision and controls (seat position check, mirror check); i.e. ensuring settled before leaving (depends if leaving a depot is highlighted as a higher risk for pedal confusion)
    - Shorter shifts; breaks;
    - Less consecutive days working;
    - Type footwear (what would this look like / how standardise?);
    - Specific training and what would this training be

10 mins

Suggested solutions.

READ OUT: I am now going show you six solutions that TfL are considering as potential solution. For each, I would like to hear your thoughts including pros and cons and the speed to which the solution could be implemented and deliver TfL Vision Zero.

- Use showcards to present each of the proposed solutions. Show in different order for different workshops, especially drivers.

Evaluate each solution

- Pros/cons for each
- Benefits and limitations of each
- How practical they believe the solution is
- How timely to implement
- How quickly can they see the solution being implemented and reference back to TfL Vision Zero
  - 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
  - No one killed in, or by, a London bus by 2030

Solutions shown in this document are for ease of reference using the PowerPoint slides to run through each one. Additional information provided on benefits/limits for moderator use only.

5 mins per solution (30 in total)

Solution 1:

Brake Toggling:

This solution would enable the driver to re-initialise their right foot/driving position and update recent memories of the brake position before leaving a bus stand/stop. **This is achieved by the driver needing to double tap the brake before the bus will move forwards (accelerate)**

This solution would also avoid errors linked with a misuse of the system (especially when the driver is not following expected protocol and does not switch gear back to neutral when stopped at a bus stop/stand).

The addition of such a solution could be fitted on an operated bus as long as (light) training is provided to the drivers.

- **Evaluate each solution**
  - Pros/cons for each
  - Benefits and limitations of each
  - How practical they believe the solution is
  - How timely to implement
  - How quickly can they see the solution being implemented and reference back to TfL Vision Zero
    - 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
    - No one killed in, or by, a London bus by 2030

Notes for moderator if need to probe:

Already a requirement on new vehicles

Table 16. Brake toggling benefits and limitations

Benefits	Limitations
• Improves right foot proprioception • Reduces foot misplacements • Quick retrofit on buses • This solution could be tested this year as a proof of concept • Short driver training time	• Retrofit limitations depending on bus models • Limited effectiveness (effectiveness expected at bus stop, bus stand only) –

Solution 2:

Accelerator noise:

Add/Amplify the accelerator engine sounds when the bus is in electric mode and at low speed (below 20mph) using the noise counter measures of the Bus Safety Standard project (AVAS).

The selected sounds to be tested will be fitted in the cab using a loudspeaker at a predetermined noise level.

- **Evaluate each solution**
  - Pros/cons for each
  - Benefits and limitations of each
  - How practical they believe the solution is
  - How timely to implement
  - How quickly can they see the solution being implemented and reference back to TfL Vision Zero
    - 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
    - No one killed in, or by, a London bus by 2030

Notes for moderator if need to probe:

Table 19. Accelerator noise conspicuity benefits and limitations

Benefits	Limitations
• Helps the driver recover from a pedal error at any location/time • Reduces pedal error consequences and occurrence • No additional driver training • Easy to implement in a bus (loudspeakers)	• Additional time to design the solution on a bus (depends on manufacturers' possibility to prototype) • Additional/specific testing required

Solution 3:

Accelerator/Brake light indicators:

Add two LEDs/lights (one light for the brake pedal activation, one light for the accelerator pedal activation) to a bus dashboard.

The LEDs/lights should be dimmed between day/night conditions. The addition of such a solution could be fitted on an operated bus as long as adequate training is provided to the drivers.

NOTE: Pedal indicator lights were a requirement of BSS buses from 2019 implementation

Evaluate each solution

- Pros/cons for each
- Benefits and limitations of each
- How practical they believe the solution is
- How timely to implement
- How quickly can they see the solution being implemented and reference back to TfL Vision Zero
    - 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
    - No one killed in, or by, a London bus by 2030

Notes for moderator if need to probe

Already a requirement on new vehicles

Table 20. Accelerator/brake lights benefits and limitations

Benefits	Limitations
• Helps the driver recover from a pedal error at any location/time • Reduces pedal error consequences and occurrence • Short additional driver training • Easy to implement in a bus (LEDs)	• Effectiveness when used alone (expected to be more effective when coupled with accelerator noise conspicuity) • Additional equipment to be fitted in a bus (could not necessarily be fitted in the main field of view on current buses)

Solution 4:

Improved Direct/indirect vision:

Use of additional visual aids to drivers to check all areas and reduce the need for body movement (including foot movement leading to misplacement) in the driver cab when making manoeuvres.

Visual driver aids such as:

- Blind spot mirrors (already fitted)
- Cameras providing external views back to driver replacing the usual wing mirrors with cameras which display view on screens in drivers cabin

NOTE: some operators introduced Camera Monitoring Systems early; they are now a requirement of the BSS 2021 for all new buses.

- **Evaluate each solution**
  - Pros/cons for each
  - Benefits and limitations of each
  - How practical they believe the solution is
  - How timely to implement
  - How quickly can they see the solution being implemented and reference back to TfL Vision Zero
    - 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
    - No one killed in, or by, a London bus by 2030

Notes for moderator if need to probe:

Table 18. Improved direct/indirect vision benefits and limitations

Benefits	Limitations
• Improves drivers visibility and driving comfort • Reduces foot and body misplacements • Reduces pedal error in left-right turn locations (e.g. includes bus stop)	• Additional equipment to be fitted to a bus (additional cost) • Less applicable in a "straight road" pedal error scenario

NOTE FOR MODERATOR:
Pedal layout standardisation and AEB solutions are unable to be retrofitted to the current fleet of buses. Introduce later unless referenced by a member of the group
PROBE: These last two cannot be retrofitted on current buses. Does this mean they should be excluded from the solutions.

Solution 5:

Advanced Emergency Braking (AEB):

Technology capable of detecting unintended acceleration errors and intervene (e.g. automatic emergency braking interpreting the acceleration signal as a brake signal when a pedal error is detected)

AEB system activation for unintended acceleration scenarios is currently not available on the market but is under development.

NOTE: AEB solutions would be unable to be retrofitted to the current fleet of buses.

Evaluate each solution

- Pros/cons for each
- Benefits and limitations of each
- How practical they believe the solution is
- How timely to implement
- How quickly can they see the solution being implemented and reference back to TfL Vision Zero
    - 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
    - No one killed in, or by, a London bus by 2030

Notes for moderator if need to probe:

Table 21. Automated Emergency Braking benefits and limitations

Benefits	Limitations
• Potential to mitigate most pedal error events depending on the level of performance of the algorithm developed • Corrects driver's cognitive errors by applying the brakes instead of the accelerator throttle	• Additional equipment to be fitted to a bus (additional cost) • Specific algorithm will need to be developed in a safe way to impede unexpected emergency braking

Solution 6:

Pedal position standardisation:

Propose a standard pedal configuration (pedal location, size, angle, pedal resistance, hanging or floor mounted) for all London buses.

NOTE: Pedal layout standardisation would be unable to be retrofitted to the current fleet of buses.

- **Evaluate each solution**
  - Pros/cons for each
  - Benefits and limitations of each
  - How practical they believe the solution is
  - How timely to implement
  - How quickly can they see the solution being implemented and reference back to TfL Vision Zero
    - 70 per cent reduction in the number of people killed or seriously injured in, or by, buses by 2022 against 2005-09 baseline
    - No one killed in, or by, a London bus by 2030

Notes for moderator if need to probe:

Table 17. Pedal standardisation benefits and limitations

Benefits	Limitations
• Improves bus standardisation • Reduces foot misplacements and adaptation time to a new bus model • No driver training time • Could be fitted on new buses	• Heavy retrofit for existing buses that could include driver's seat retrofit • Limited effectiveness (e.g. does not address cognitive errors) • International standard currently under review (updated version expected in 2018) • Requires advanced mock-ups

Conclusions about solutions

- What are the best solutions in terms of:
  - Time (short term/long term)
  - Safety
  - Practicality (ease of implementation)
- Is there a mix of solutions required, if yes, what is the mix?
- Assume cost and practicality are not a barrier and rank each solution for short term (2022) and long term (2030)
- Any additional solutions that should be included (based on their initial thoughts) which would add to their preferences / improve final outcome and goal

10 mins

Thank and Close

Appendix E Data Tables

		Count	%
Which bus operator do you work for?	Abellio	90	15
	Arriva	167	28
	HCT Group	42	7
	Go-Ahead	1	0
	Metroline	116	20
	RATP Dev	17	3
	Stagecoach London	131	22
	Sullivan Buses	0	0
	Tower Transit	28	5
	Uno	0	0
	Other	1	0
	Base	593	100

		Count	%
Which of the following best describes your job role?	Bus driver	567	96
	Bus driver trainer	7	1
	Bus depot manager	4	1
	Health and Safety manager	4	1
	Engineer	1	0
	Engineering Manager	0	0
	Work in an admin role at the bus depot not directly with buses	1	0
	Other	9	2
	Base	593	100

		Count	%
How long have you worked in Base as a bus driver?	One year or less	87	15
	Between one and three years	69	12
	Between three and five years	70	12
	Between five and 10 years	79	14
	Over 10 years	262	46
	Base	567	100

		Count	%
Before your current role had you ever worked as a bus driver?	Yes	21	81
	No	5	19
	Base	26	100

		Count	%
How long did you work as a bus driver?	One year or less	0	0
	Between one and three years	4	19
	Between three and five years	3	14
	Between five and 10 years	6	29
	Over 10 years	8	38
	Base	21	100

		Count	%
How long have you worked in the bus industry?	One year or less	85	14
	Between one and three years	66	11
	Between three and five years	69	12
	Between five and 10 years	80	13
	Over 10 years	293	49
	Base	593	100

		Count	%
Typically, how many different buses do you drive in one shift, even if it's the same make/model of bus?	1	79	14
	2	435	77
	3	45	8
	4 or more	8	1
	Base	567	100

		Count	%
Typically, how many different makes/models of bus do you drive in one shift?	1	146	30
	2	304	62
	3	33	7
	4 or more	5	1
	Base	488	100

		Count	%
Which of these makes of bus do you drive or have you driven	ADL	205	35
	BYD	76	13
	Caetano	39	7
	MCV	69	12
	Mercedes Citaro	61	10
	Optare	132	22
	Scania	201	34
	Wrightbus	236	40
	Other	218	37
	Base	588	100

		Count	%
When changing buses, typically how much time do you take from your bus arriving until you drive it away?	5 minutes or less	346	71
	More than 5, up to 10 minutes	115	24
	More than 10, up to 15 minutes	17	3
	Over 15 minutes	10	2
	Base	488	100

		Count	%
How frequently do you believe pedal confusion occurs amongst London bus drivers even if there isn't a collision?	At least once a week	142	24
	Less than weekly but at least once a month	50	8
	Less than once a month but at least once every 3 months	26	4
	Less than once every 3 months but at least once every 6 months	13	2
	Less than once every 6 months but at least once a year	24	4
	Less than once a year but it does happen	59	10
	I'm not aware of this ever happening	87	15
	Prefer not to say	5	1
	Don't know	187	32
	Base	593	100

		Count	%
Have you ever received training about pedal confusion, either when you joined the company or since?	Yes	188	32
	No	299	51
	Don't know / Can't remember	101	17
	Base	588	100

		Count	%
At what point in a journey do you think pedal confusion is most likely to occur?	Setting off from a depot	30	5
	Setting off from a bus stop	52	9
	At a junction, setting off	54	9
	At a junction, slowing down	126	21
	Slowing down for a bus stop	52	9
	Driving back into a depot	13	2
	Other	65	11
	Don't know	201	34
	Base	593	100

		Count	%
At what point in a shift do you think pedal confusion is most likely to occur?	At the start of a shift	34	6
	Just before a break	10	2
	Just after a break	16	3
	Near the end of the shift	132	22
	At any time a driver changes buses	36	6
	At any point in the shift, the time isn't a factor	196	33
	Other	15	3
	Don't know	154	26
	Base	593	100

		Count	%
Which of the list below do you believe are the main factors that lead to pedal confusion? Please select the top three factors Please note any other factors not listed that may lead to pedal confusion?	Switching from one bus to another, even if it's the same make/model	68	11
	Passengers distracting the driver inside the bus	81	14
	Pedestrians distracting the driver outside the bus	34	6
	Other road users distracting the driver	44	7
	A driver's mind wandering and losing concentration	200	34
	At blind spots where a driver may concentrate on making sure they don't hit anything or anyone	38	6
	At traffic lights / road junctions where other road users move in front of buses	89	15
	At bus stops when other road vehicles do not let buses out	30	5
	Driving in heavy traffic (stop/start)	115	19
	Driving when dark	12	2
	Driving a night bus	9	2
	Driver fatigue	329	55
	Human error	304	51
	Drivers not being able to hear when the bus is accelerating	26	4
	Lack of experience / new drivers	7	1
	Stress	17	3
	Over confidence	3	1
	Weather	2	0
	Seats incorrectly installed / uncomfortable	4	1
	Training is inadequate / non existent	6	1
	Pedal shape / placement / layout	26	4
	Low skilled drivers	3	1
	Bad cab layout / driver conditions	6	1
	Hurry / rushing / panic; including pressure from operator iBus controllers	21	4
	Footwear	6	1
	Not using handbrake	2	0
	Alcohol / drug taking	3	1
	Other	18	3
	Base	593	100

		Count	%
What experience do you have of pedal confusion?	I've experienced pedal confusion myself	127	21
	I'm aware of pedal confusion happening to other drivers	157	26
	I know what it is but do not know of any experiences	219	37
	I do not have any knowledge of pedal confusion	131	22
	Base	593	100

		Count	%
What is your personal experience of pedal confusion?	Using the accelerator instead of the brake	73	57
	Using the brake instead of the accelerator	31	24
	I've used both the accelerator instead of the brake and brake instead of the accelerator	21	17
	Other	6	5
	Base	127	100

		Count	%
What type of vehicle were you driving?	Petrol	7	6
	Diesel	58	46
	Hybrid	52	41
	Don't know / Can't remember	10	8
	Base	127	100

		Count	%
Can you recall the make and / or model of the vehicle you were driving?	Yes	44	35
	No	83	65
	Base	127	100

		Count	%
How many times have you experienced pedal confusion in the past year?	0	55	43
	1	46	36
	2	14	11
	3	5	4
	4	2	2
	5	5	4
	Base	127	100

		Count	%
How many times has the pedal confusion led to a collision in the past year?	0	118	93
	1	7	6
	2	1	1
	5	1	1
	Base	127	100

		Count	%
What is your knowledge of the occasions when another driver had pedal confusion?	The driver used the accelerator instead of the brake	113	72
	The driver used the brake instead of the accelerator	23	15
	Other	1	1
	Don't know the details	34	22
	Base	157	100

		Count	%
How many different drivers have mentioned they've experienced pedal confusion in the past year?	0	47	30
	1	27	17
	2	29	18
	3	24	15
	4	6	4
	5	12	8
	6	3	2
	7	2	1
	10	5	3
	12	2	1
	Base	157	100

		Count	%
What was the outcome of the incident(s)?	There has been a collision which involved another person (including cyclists/car drivers)	51	32
	There has been a collision which involved an object (e.g. a tree or lamppost) but not a person	58	37
	Passengers were jolted, but no outside collision	29	18
	There was a near miss as driver successfully recovered the situation, no collision and passengers unaffected	48	31
	Other	15	10
	Base	157	100

		Count	%
How many times have you heard of drivers experiencing pedal confusion in the past year?	0	45	29
	1	40	25
	2	22	14
	3	19	12
	4	11	7
	5	9	6
	6 or more	11	8
	Base	157	100

		Count	%
How many times has the pedal confusion led to a collision in the past year?	0	96	61
	1	30	19
	2	11	7
	3	11	7
	4 or more	9	6
	Base	157	100

		Count	%
I have been trained to recognise when unintended acceleration is occurring and how to respond to it	Strongly agree	105	19
	Agree	164	29
	Neither agree nor disagree	158	28
	Disagree	67	12
	Strongly disagree	73	13
	Base	567	100

		Count	%
How frequently do you choose to “coast”?	Very frequently (multiple times on a route)	46	8
	Frequently (at least once on a route)	33	6
	Occasionally	105	19
	Rarely	139	25
	Never	244	43
	Base	567	100

		Count	%
Which of these places are you most likely to “coast”?	Sitting in slow moving traffic	100	54
	Once I’m up to speed and I see traffic ahead	85	46
	Arriving at a bus stop	45	24
	Arriving at the depot	18	10
	Other	6	3
	Base	184	100

		Count	%
Forcing a driver to apply the brake pedal before engaging a gear to drive away (e.g. when leaving the depot or bus stop)	Strongly agree	131	22
	Agree	206	35
	Neither agree nor disagree	164	28
	Disagree	54	9
	Strongly disagree	38	6
	Base	593	100

		Count	%
Having the same types of pedals and pedal layout for all makes/models of bus	Strongly agree	230	39
	Agree	216	36
	Neither agree nor disagree	106	18
	Disagree	28	5
	Strongly disagree	13	2
	Base	593	100

		Count	%
Making sure drivers can see all around the exterior of the bus before setting off, i.e. no more blind spots	Strongly agree	197	33
	Agree	212	36
	Neither agree nor disagree	126	21
	Disagree	41	7
	Strongly disagree	17	3
	Base	593	100

		Count	%
Having an audible cue to inform the driver when the bus is accelerating from a low speed or stationary position	Strongly agree	116	20
	Agree	179	30
	Neither agree nor disagree	177	30
	Disagree	71	12
	Strongly disagree	50	8
	Base	593	100

		Count	%
Having a visible cue, such as a light, to inform the driver when the accelerator and brake pedal are being pressed	Strongly agree	131	22
	Agree	213	36
	Neither agree nor disagree	155	26
	Disagree	52	9
	Strongly disagree	42	7
	Base	593	100

		Count	%
A detector to automatically brake, based on sensors which deem when a bus is likely to be unintentionally accelerating	Strongly agree	147	25
	Agree	198	33
	Neither agree nor disagree	147	25
	Disagree	54	9
	Strongly disagree	47	8
	Base	593	100

		Count	%
Drivers being provided with approved footwear to be used when driving buses	Strongly agree	157	26
	Agree	191	32
	Neither agree nor disagree	146	25
	Disagree	62	10
	Strongly disagree	37	6
	Base	593	100

		Count	%
Giving drivers time to prepare when changing buses	Strongly agree	241	41
	Agree	205	35
	Neither agree nor disagree	108	18
	Disagree	25	4
	Strongly disagree	14	2
	Base	593	100

		Count	%
Using the same bus for the whole shift	Strongly agree	177	30
	Agree	162	27
	Neither agree nor disagree	178	30
	Disagree	50	8
	Strongly disagree	26	4
	Base	593	100

		Count	%
	Agree	231	39
	Neither agree nor disagree	101	17
	Disagree	15	3
	Strongly disagree	10	2
	Base	593	100

Appendix F Possible causes of pedal confusion: Quotes from workshops

Topic	Quote by	Quote
Different pedal configurations or cab design	Bus Driver	"On the electric buses, on the hybrids that I drive the pedals are much closer together and the cab is much smaller and also when you take off in one of those buses as well, when you take off in electric mode, it can be quite confusing, it can be quiet, because you think oh crumbs! But definitely an electric bus, the cab seating area is much smaller, because you've got the batteries behind you."
Different pedal configurations or cab design	Union Officials	"The actual layout of the pedals is a massive, massive concern and we do believe that it's probably second, only second to fatigue"
Different pedal configurations or cab design	TfL Operations	"Sometimes they're too close to each other, the pedals. Obviously, your orientation, you push down, and if the pedals are too close to each other, so obviously you don't know which one you're pressing."
Different pedal configurations or cab design	Operator Health and Safety	"The pedals are both floor mounted, push down, they're very close at the base and they spread out slightly. So, it encourages you…[to]...leave your heel where it is and it's across both pedals, which then gives you the potential issue of covering the pedals. The other issue is there's less than 5mm difference between the height of the pedals, the accelerator and the brake pedal, so if you are twisting your foot it's very easy to slide between the pedals, so we've also had instances where we're covering both pedals, whereas if you look at it on some of the other bus designs, they're square on, so you need to move your heel slightly, but there's also a lot bigger difference between [the pedals] 25 and 30 mm difference"
Different pedal configurations or cab design	Operator Health and Safety	"We photographed every pedal on every bus type, we've measured them, we've seen the issues, you know, with particular incidents we've had, does that reflect the pedal box? After a lot of work on doing that, we came to the conclusion well, no, there wasn't, not significantly or not sufficient that there's a real cause there, but that's me and six or seven pedal confusion incidents"
Traffic	Incident Investigators	"Or when slow moving traffic, they're on and off from one pedal to the other, therefore sometimes that can work that they actually think they're pressing the brake, when they're actually pressing the accelerator."

Topic	Quote by	Quote
Hybrid and electric buses	TfL Health and Safety	"I think sort of the quiet running buses, again in terms of those sort of where electric buses generally are able to get a little bit more torque and acceleration quicker, so we do sort of see those where they can go from stationary to moving and again the situation getting out of control probably a little bit quicker than maybe we sort of do with conventional diesel based engine"
Hybrid and electric buses	Engineers	"Just taking on what you're saying, regeneration on a hybrid and electric vehicle, you take your foot off, the bus is slowing down, you've got more chances of pedal confusion [at a slower speed] than where you're driving at a higher speed"
Hybrid and electric buses	Union Representatives	"There's one more other thing really with the electric buses is the regeneration of power. So, the batteries are not sufficient, so they have to regenerate and that's what causes that problem with the accelerator. It's always braking."
Footwear choice / lack of feeling of the pedals underfoot	Bus Driver	"When I first started on the buses I found that the shoes that you would wear were quite clumpy compared to what you'd say you'd use in your car and I did find a lot of the time that when you were pressing the accelerator [or] vice versa, your shoe would be sort of clipping the pedal next door."
Footwear choice / lack of feeling of the pedals underfoot	Union representatives	"A lot of them wear trainers and nobody controls them."
Footwear choice / lack of feeling of the pedals underfoot	*Bus Driver*	"Signing on in the morning, the difference in trainers, shoes that are falling apart, all kinds of different footwear, if you're not wearing the proper footwear, your shoe, which is the sole's coming apart or whatever can easily, you know, your foot can slip, maybe, so maybe the footwear should be examined by management"
Driving different models of bus on the same shift / general unfamiliarity with the bus design	Bus Driver	"It's the types of buses, because there are so many different types of buses, left indicators, right indicators, opening doors, closing doors is also different. It's not ergonomically designed for the seat adjustment, take our buses changeover and all [that] applies and the response time of each vehicle, even if it's made from the same model won't respond exactly the same, the steering will be different, the acceleration and the brake response will be different for each bus, individually you have to get used to it."

Topic	Quote by	Quote
General driver distraction	Operator Operations	"You know, when you do a root cause analysis, all the incidents that I've dealt with it tends to be something like fatigue, not concentrating, chatting to their buddies, potentially on the bus with them and many other factors that potentially lead to that I think we probably need to focus more on them and then obviously pedal confusion can't potentially get rid of it, because you never plan to do it, but it's then what do you do with that, but I'd definitely look at it as a wider aspect than simply that they're just confusing it."
Radio controllers contacting drivers	Bus Driver	"If they're feeling under pressure to reach a certain place by a certain time, because the drivers usually always want to make sure that they've got their stand time. If the running time is so short, no matter what they do they're going to miss that stand time, that will play on their heads as well or if they've left a few minutes late for whatever reason."
Radio controllers contacting drivers	Operator Health and Safety discussion	"Why do they radio buttons have to be on the floor…. I know drivers shouldn't answer their radios when they're driving, we tell them, but most of us all know that they probably do. Why can it not be on the steering wheel". "You're right and it probably is an element, because if you use it and you're in a rush to put your foot back to the brake or whatever else, so it's not ideal. You almost want it to be deactivated when it's in motion."
Passengers / passenger behaviour	Bus Driver	"Passengers talk with the driver when they are driving which is distracting."
Passengers / passenger behaviour	Incident Investigators	"So we've had a case recently where you clearly see the driver, if he leans out of the cab to talk to a passenger and as he recedes, just because his body isn't aligned with the pedals, I mean it happens almost instantaneously, that's just probably the way he hasn't checked where his feet are."
Topic	**Quote by**	**Quote**
Home life pressures need to pick the children up, family commitments	Bus Driver	"A lot of people think you just make a journey and it's not just like that, you have got to deal with time, you've got a time restriction to get from A to B and if you don't make it in time they sort of spin you around in the middle and send you back on yourself, so you get passengers that get a bit irate, you get the school rush, you've got quite a lot of things to deal with, so I think that you tend to get fatigued quite easily as a driver and I think that that's where you can make mistakes."

Drivers rushing: To achieve their stand time or to finish a shift	Operator Operations	“The bus started to move forward in slow moving traffic, it was behind schedule, so he wants to push, push, push, he can see the way off, starts to move away, the traffic stops, he puts his foot on what he believes is the brake, it’s not, it’s the accelerator”
No toilet facilities in rest areas	Bus Driver	“I was reading an article in the United States, where it stated that in their bus driver system, sometimes people get involved in an accident because when they’re too desperate to go to the toilet and your body system is really kind of like all over the place, you’re like holding on, you’re trying to right, you know, I’ve got ten minutes to get to the stand, so I can go to the toilet, that can give you, your body reaction, without even you realising it mentally…. physically your body cannot react, you don’t get the right signals of what pedal to press”
Tiredness / fatigue	Bus Driver	“Also driver fatigue, I think driver fatigue is the main thing in there and just basically driver error, unfortunately.”

Appendix G Possible solutions to pedal confusion: Quotes from workshops

Brake Toggling

Topic	Quote by	Quote
Brake Toggling	Operator Operations	"[Pedal confusion] tends to happen in slow moving traffic, when we're going quite slowly and something happens, that might not necessarily have come in"
Brake Toggling	Bus Driver	"Then that doesn't solve the solution, because pedal confusion comes when you're, say like you're on the road and the bus is actually moving."
Brake toggling as a benefit	Manufacturers	"So making the driver find the two pedals sequentially every now and again when he starts his shift or near a bus stop or something, it feels like that's probably a positive thing, but it's just a judgement, I don't have any data behind that."
Brake toggling as a limitation	Operators Health and Safety	"You also run into unintended consequences with this toggling, which we found, because we've got it on our new electric buses and they've recently changed, but what we've found was drivers weren't using the handbrake."

Accelerator Sound (audible cue)

Topic	Quote by	Quote
Accelerator sound as a benefit	TfL Health and Safety	"I think there have been occasions where pedal confusion has occurred because the driver psychologically perhaps isn't aware that the bus is moving, because there isn't a noise, if that makes sense, but I'll temper that with there is a lot going on in a bus driver's cab"
Accelerator sound as a benefit	Operator Health and Safety	"The noise just drags their attention back to the front windscreen. So that's an improvement, but that doesn't fix this [pedal confusion], so I'm not throwing out noise completely, but what I'm saying is it has a very limited benefit"
Accelerator sound as a benefit	Bus Driver	"With the electrical buses, we are missing the sound of the engine. So, I think it would be such an idea, when you press the accelerator to make a noise that make it shows that, we enjoy the sound of the engine, but now we need to enjoy something about the electrical engine, like a buzzer or I don't know, whatever they decide. At least you are in control by listening to it"
Accelerator sound as a limitation	Union Official	"By the time they're hearing the noise the incident's happening, this doesn't prevent it…….It all happens in a split second and this does nothing except tell the person you're making a mistake….even it was saying accelerating,

		accelerating, accelerating, accelerating, if we're talking about the focus issue here, I don't think it does enough"
Accelerator sound as a limitation	Union representatives	"You're getting beeping sounds from the controllers, where you get signals are coming and then you've got things that come on for the passengers as well, so you've got all these different things happening, when really you just need to concentrate on that road and what's ahead of you."
Accelerator sound as a limitation	TfL Health and Safety	"Sometimes we talk about distractions in cab now and we're actually putting more and more distractions into the cab for the driver just to sit there and shrug his shoulders and go, really, I haven't got a clue what alarm's going off now, because that one sounds like that, that one sounds like that"
Accelerator sound as a limitation	Driver Trainers	"It'll be okay for the first few times but then the drivers will switch off, it's just another annoyance that they'll just ignore."
Past experience	Operator Health and Safety	"We've had this on diesel buses….. they still don't take their foot off the pedal. It doesn't get through, the nature, human nature part of it."
Recommendations	TfL Operations	"I would like to see is a universal buzzer, so the bus you drive, by what manufacturer, if it's that noise you know it's that, if it's that noise you know it's that, whereas currently each manufacturer has its own buzzer or bells or whistles" TfL Operations
Recommendations	Manufacturers	"So if you progressively and smoothly press the accelerator in a controlled way, you either get perhaps no feedback sound or a very low level sound. If you stamp on it you get the same sound, but a lot louder or shriller or something. So, the driver gets used to the sound, but it's at very low level, so it's not an annoyance and it actually encourages the driver to use the accelerator pedal gently and smoothly, because that's nicest in terms of avoiding noises"

Accelerator / Brake light indicators (visual cue)

Topic	Quote by	Quote
Accelerator / brake light indicator as a benefit	Bus Driver	"Because it's telling you, the lights are telling you what you've got your foot on."
Accelerator / brake light indicator as a benefit	Operator Operations	"I also see the benefits of it, it probably can be quite simply done, it's in a lot of modern cars now for gear changes and it does help sometimes. That might potentially benefit to an extent, but I don't think it will be the solution."
Accelerator / brake light indicator as a benefit	Operator Operations	"Yes, whether it would make a difference, I guess, but it's probably one of the more cost effective and sort of straightforward ones that could be added."
Accelerator / brake light indicator as a limitation	Operator Operations	"I think it's that reaction and whatever it is that can help with that, but I still can't get away from this is unintended, it's over reaction, we're adding something else into it, are they genuinely going to react how we'd like them to which is press [the] brake."
Accelerator / brake light indicator as a limitation	Union representatives	"If you're talking about pedal confusion and you're [adding a light] , it's taking away the guy's concentration from the pedal and he's now looking at the light".
Accelerator / brake light indicator as a limitation	Union Official.	"You see my view is I'm not looking at the dashboard, I'm looking out the window. Where I'm going I'm looking at my surroundings. So, actually if we had a light on the dash, it'd probably be the last thing, you know, between the noise and that, I would hear a noise, but I wouldn't see that light"
Accelerator / brake light indicator as a limitation	Manufacturers	"My feeling is that the visual warnings are much lower value than an audible warning, because you have to be looking at a warning or you have a huge warning light that's going to be a massive distraction a lot of the time, in order to not require the driver to look at the instrument panel. The likelihood of the driver looking at the instrument panel to analyse what's gone wrong is, I would say, pretty low."

Improved Direct / Indirect vision for a driver inside the cab

Topic	Quote by	Quote
Improved direct/indirect vision as a benefit	Incident Investigators	"We've had a case [incident] recently where you clearly see the driver, he leans out of the cab to talk to a passenger and as he recedes, just because his body isn't aligned with the pedals, it happens almost instantaneously, that's just probably the way he hasn't checked where his feet are."

Improved direct/indirect vision as a benefit	Bus Driver	“Yes, you are less distracted, you are concentrating more, so somehow, part of what we said earlier is distraction actually leads to pedal confusion…. So I’m all for it.”
Improved direct/indirect vision as a limitation	Operator Health and Safety	“I don’t see how that’s going to improve pedal confusion. It can help with other things.”
Improved direct/indirect vision as a limitation	Operator Health and Safety	“I mean a lot of drivers when the weather’s hot, there’s a bit of a window, putting their arm out the window like they was driving a sports car, so again that’s a change in position. I don’t think it’s [pedal confusion] got anything to do with it”
Improved direct/indirect vision as a limitation	Operator Operations	“I think it’s basically trying to say that if you didn’t have these things, you’d be therefore moving your foot position, but I don’t necessarily agree with that.”
Improved direct/indirect vision as a limitation	Union Officials	“I think teaching people how to use their seats, teaching people how to position themselves for the pedal would be more beneficial than something we’ve already got.”

Advanced Emergency Braking (AEB)

Topic	*Quote by*	*Quote*
AEB as a benefit	Operator Operations	“To me it’s certainly the one that makes the most sense, because that is the problem and it tackles it directly, it’s interesting”
AEB as a benefit	TfL Health and Safety	“This is one that sort of seems to definitely be an intervention that could prevent these incidents from sort of ending in tears.”
AEB as a benefit	Bus Driver	“Yeah, I think it would be a good thing. Anything that would actually help us I think is a good thing. I used to have, on the car that I used to drive, it used to have the technology where it used to keep you in the lane, whereas if you used to start to drift slightly out of your lane it would automatically correct the steering wheel and sort of bring you back in, but yeah, obviously if you’re going to accidentally hit the accelerator and the bus can sense that there’s something in front and then it’s going to correct that, that can only be a good thing.“
AEB as a part benefit	Operator Health and Safety	“So it’s not going to change the fact we’ll have pedal confusion incidents, it’s just mitigating the effect. Because I think the velocity of the vehicles still means that there might be some immediate damage.”
AEB as a part benefit	Operator Health and Safety	“Yorkshire that had that case where they hit ten different vehicles on the road, it would certainly reduce that, because at some point after the first collision hopefully, but of course, that first collision could be a bus queue of people, it could be someone crossing the road.”
AEB technology	Bus Driver	“Yes, definitely, I think that would be something to explore. I don’t know how, if the technology would work on such a vehicle as a bus and I guess ..., but it’s definitely worth looking at, 100%.”
AEB technology	Operator Health and Safety	“It depends how the system works, because potentially certainly some of the [incidents] I can think of, you’re so close when it happens, is the system actually going to work for that?”
AEB in busy areas	Union Officials	“I think it’s a good idea. I think it’s okay if you’ve got something that works from a distance, that will reduce the speed down to say anything up to a metre, they would apply the brakes, but it’s how it would apply the brakes. What we can’t do is get into a situation where if it gets down to a metre that the bus will just stop, because we don’t know what speed that bus will be doing when it gets down to a metre.”

AEB in busy areas	TfL Health and Safety	"I think in busy areas, like Oxford Street, I think depending on how the technology work it might prove a challenge trying to drive a bus through a street with crowded pedestrians with the system not, malfunctioning or being oversensitive. So that's the only thing that kind of comes to mind in terms of being a limitation."
AEB technology	Manufacturers discussion	"It's a very high risk that the system will intervene at the wrong time, you know, the full scenario is you're overtaking a cyclist and a van comes round the bend on the other side of the road, faster than you're expecting, you have to either abort the manoeuvre or continue it. You take the judgement to continue it, so you stamp on the accelerator and then the bus comes to a halt in the middle of the road in front of the van." "How would this have bearing on the pedal confusion itself. I know that there's a different working on ABS and the amount of accidents that that might cause or create, but for the topic of pedal confusion how does it connect?" "It's very tricky, to pinpoint the unintended accelerations out of all the intended ones, because I mean regardless of the surroundings outside, sometimes the intended acceleration maybe is trying to avert another danger that the system for emergency braking doesn't see, like it doesn't take the complete picture, like the driver has to do."
AEB technology	Bus Driver	"From what I understand from this, it's meant to detect when you're accelerating or braking and basically cut it out when it thinks that you're doing it as a mistake. So, how does it know, because imagine I'm not doing it as a mistake?"
AEB technology	Bus Driver	"For me it looks like so advanced, so far away from the solution that we shouldn't even be part of it. Like this would be, I would see, you know, those self-driving cars. So the car itself predicts when it's going to accelerate or when it's going to brake. And it controls its prediction to the driver's reaction and that's what it does, but it's still science fiction to me, you know, where we are now."
AEB technology	Bus Driver	"Can you imagine that emergency brake with sixty people on board? Maybe on a small car it works, but on the bus, I think you have to be in control of it. I don't know how harsh the braking is and emergency stop on the bus is."
AEB technology	Bus Driver	"Yes, but how's it going to stop the bus, is it going to stop the bus suddenly, like how close do we have to be for it to detect that, oh my gosh, it's something, is it going to do a big shunt, is it going

		to be dangerous for passengers maybe standing up?"
AEB technology	Engineers	"If you think about the principal of what AEB does, you can't accelerate if something's in the way. It's just how good those sensors are. So, like some of you guys in here, we've all trialled all these bike and person monitoring devices and you have things going off, you go down Oxford Street and you might not get anywhere, so it's got to be right."
Other observations from the workshops	Bus Driver	"Any technology that can help is never going to be a bad thing, but I think the issue is so small that spending this sort of money on it doesn't make a lot of sense to me. I think there's bigger issues than pedal confusion."
Other observations from the workshops	Bus Driver	"I don't know if I'd be too happy with something braking for me. You know, there's been so much with these cars now with lane changes where they don't do it right and automatic braking systems that don't work. I think it would be a wrong way to go by virtue of the fact that people may back off of braking, because they know that, something's going to stop. I think laziness would start to creep in, personally."

Advanced Emergency Braking (AEB) discussions about interim solutions

Topic	*Quote by*	*Quote*
Interim solution suggested in the workshops	Operator Operations discussion	"I'm really surprised, to be honest, that it's only under development. I would have thought that there'd be something……, there's going to be stock data in terms of how much pressure you'd ergonomically, right, to apply to the brake pedal and the accelerator, they do have different weights." "so all you need is some software that tells you that pressure over a certain amount." "Yes, you have like a pressure sensor on the accelerator and it'll signal".
Interim solution suggested in the workshops	Engineers discussion	"You've got two differences, acceleration, which is minutes per second squared and then you've got minutes per second cubed and it's based with the time to go from zero to one minute per second squared, so it's like that, if you ramp up to one minute per second squared in ten seconds, that feels gradual, like it gets thrown, that's when it goes from 0-1 instantly. So, it might only cover half a metre, but it scares the driver, so it might actually, they might not actually travel very far, but like to them … "Could we not have something on the vehicle that cut out the signal but took away speed, took away acceleration? You press the throttle and it'll kick down, to try and get away quickly, you know, there'll be like a little kick down switch just behind the throttle, 95% feeling under foot. I wonder whether in kick down, whether you just instead, because like you were saying, when they panic, the driver panics. Foot goes down. Stamp and I just wonder whether you just if it goes 100% or 95%. Take away the throttle. They've still got time to react." "Something on your steering wheel where you have to click it to get acceleration, maybe that's where, if you want full acceleration you do that. So if you're pulling away into fast traffic. You click back to give yourself that boost. And then if someone hits the pedal. And obviously, it's not obviously, pedal confusion, but if they put their foot down and it doesn't react, you've got the ability for that boost, but if they put their foot down in the scenarios we've been talking about, because they think they're going to the brake and their foot doesn't come off of it, it should cut out."

Pedal Standardisation

Topic	Quote by	Quote
Benefits of Pedal Standardisation as a solution	Bus Driver	"This is the best one, this is the best one, yeah. Because each bus or each maker, they've got slightly difference. Like the 18s, they are different from the ADHs, you know, the pedals, the distance, how you sit as well, you know."
Benefits of Pedal Standardisation as a solution	Bus Driver	"Yeah, that would work. If every single bus you got on was all the same and the brake pedal is like a normal car brake pedal, where it's a lot squarer, where it's a lot squarer, where it accelerates. On our buses the accelerator pedal and the brake pedal are almost exactly the same."
Findings from the workshops	Operator Health and Safety	"It wouldn't solve everything, but I think it would have the biggest impact, as a single item"
Benefits of Pedal Standardisation as a solution	Bus Driver	"I think if you were to get to a position where every bus had the pedals in the same position with the same gap, it would help the drivers, because obviously we've all said that sometimes we're driving one bus and one half or one bus today and a different bus tomorrow. So, yeah, that's a positive, definitely."
Benefits of Pedal Standardisation as a solution	TfL Health and Safety	"For me, I think it would benefit a lot of people, because you familiarise yourself and you just take away another way out, for want of a better term, for the driver and it's standardised for all vehicles, yeah, definitely."
Considerations for Pedal Standardisation	Bus Driver	"It must be a little bit higher than the accelerator, a bit closer to the driver, …, I mean the position should be central when it normally is, but with a different size of pedal, different from the accelerator."
Considerations for Pedal Standardisation	Bus Driver	"To have them more separated, more apart from each other. That's one of the, I think that could be a good solution"
Considerations for Pedal Standardisation	Driver Trainer	"I see something for actual hanging pedals, as in if you have flat type pedals then the foot could slide up on the pedal, whereas if you put them down like a conventional car, then perhaps that might take away or having two pedals, as was said before, the old mushroom type, so if you have one pedal that does …, another pedal and therefore, you know, you're going to have a completely different feel."
Considerations for Pedal Standardisation	Union Officials	"If you physically have to move your feet to hit the brake or the accelerator, that means you have to register it with your brain and I think it's a big thing to do that and we've got away from that, which I think is quite a big concern."

Considerations for Pedal Standardisation	Union Officials	"[On electric buses] the pedals are identical side by side and I think that there's something that we can do there, even if it means just, look, I'm no engineering expert, but I'm pretty sure that without changing the linkage we could easily move the pedal over on the right hand side and move the left hand pedal towards the left and that would create the gap"
Considerations for Pedal Standardisation	Engineers	"It's naturally easy in a driver's cab to press the throttle at 100% than it is to press the brake at 100%. It needs to be the other way round, it needs to be harder to press the throttle and easier to press the brake."
Caveats to Pedal Standardisation	Operator Health and Safety	"I think from our point of view the best pedal box design is the accelerator is floor mounted, so it's push down. The brake pedal is a swing pedal, more likely to have in a car, so it's a very different action between them……and you physically need to move your foot across"
Caveats to Pedal Standardisation	Engineers	"You slip off the top of the pedal if you've got wet shoes as well…..but if it was mounted at an angle and you push into it and that felt more different from a high pitch compared to throttle."
Caveats to Pedal Standardisation	Engineers	"Just bear in mind that if you get Pedal Standardisation wrong, it causes problems for the lot."
Caveats to Pedal Standardisation	TfL Health and Safety	"The limitations would be if you do it to 9,000 plus vehicles and then we start to have pedal confusion on them, then we are screwed, yes, the NRMs, we've got a thousand of them, so again obviously there is a debate as to kind of, is it sort of volumes in the fleet that kind of make them more likely to. It's that being absolutely certain that kind of the design you've chosen is the right one, because otherwise, yeah, it presents quite a large issue."
Limitations of Pedal Standardisation as a solution	Bus Driver	"Yeah, I drove a bus with the pedals hanging and it felt like so strange. When I try to hold the brake, I can't hold the brake properly, because my foot is resting down too hard and the brake is going now, so I try to accelerate, the accelerator is going too hard, because it just feels different, when the pedals are in the … inaudible and that time, that's the first time I actually drive that bus."
Limitations of Pedal Standardisation as a solution	Operator Health and Safety.	"I think there's some element to the design of the pedal configuration which you would think could be designed out and improved on, but I think even if we had complete standardisation of pedals across the bus industry, that may make a difference and remove pedal confusion, but I think we'd still have pedal confusion…..it's just an element of it, rather than a real solution"

Limitations of Pedal Standardisation as a solution	Manufacturers	“The only thing about the standards, they tend to have a fairly big range in which you can comply with the standard. From memory there’s a sort of recommended area and there’s a required area and I think there’s quite a big tolerance on it, in terms of pedal positions and seat position and steering column position relative to accelerator heel point and that type of thing…… the tolerances of these recommendations aren’t usually to accommodate for different heights for drivers etc, because many times we have come across the problem that some of the drivers are inside the tolerances and some of the drivers are not, because these tolerances are for a population,”
Limitations of Pedal Standardisation as a solution	Manufacturers	“From our point of view we design all our cabs to meet the ISO ergonomic standard... I don’t know if anyone’s done any more work to see whether the standard is valid and the pedal positions relative to each other are good and accurate….it might be that maybe a bit more investigation needs to be done.”
Limitations of Pedal Standardisation as a solution	Operator Health and Safety	“But also, it’s drumming into the drivers that your foot should always be over one, the pedal, regardless of what your vehicle’s doing, don’t rest it on the floor.”
Limitations of Pedal Standardisation as a solution Limitations of Pedal Standardisation as a solution	Operator Health and Safety	“I think that’s just poor practice, because rather than placing your foot properly on the pedals, you’re using it in a lazy fashion, so I think that’s just poor placement.”
Other observations from the workshops	Driver Trainer	“I still, me personally I still think there needs to be, even for each vehicle to be the same there’s got to be that retraining, hasn’t there, people have got to be retrained for that.”
Other observations from the workshops	Operator Health and Safety	“There are some bus types that you don’t have pedal confusions, they’re the ones we should be looking at to see what is it about those pedals and the configuration that has contributed and we have had incidents with those buses, but again I don’t think Pedal Standardisation would stop all this.”
Other observations from the workshops	Manufacturers	“I think it needs more of a study as to how the driver is sat and interacts, rather than potentially the pedals themselves.”

Other observations from the workshops	Bus Driver	“They need to talk to us. We are the ones driving. We know what works and what doesn’t. Not people sat in an office.”
Other observations from the workshops	Union Officials	“We don’t get involved in cab designs anymore….and that’s the biggest problem, no-one consults the bus driver anymore. It’s about what the manufacturer wants, yeah and what they may think is okay in a lorry or whatever, maybe not ideal for any bus, whether it be a London bus or whatever.”
Other observations from the workshops	Union Representatives	“I think the best solution is to get those who are concerned, which is the drivers and the union in the process of design and that’s the only time this problem can be solved.”

Report 6.4 Quotes Other suggested solutions: Workshops

Topic	Quote By	Quote
Cut-off switch	Operator Operations.	“The idea of like a dead man’s switch is not new at all. I think most mechanical equipment they’ve got, safety devices and things like that and there are plenty of, so if you look at other things, technically it’s just a couple of pedals”
Cut-off switch	Union representatives.	“In milk floats…..you put your foot down hard on the accelerator there was a cut-off, like a little button underneath, like a dead man’s switch. So, the vehicle wouldn’t go nowhere. It would stop you from, you’d put your foot down, because you’d believe you were on the brake and you’d put it down harder. So, as soon as you put it down harder it would cut out”
Regeneration	Engineers	“You can change the pedal, you can tweak the regen, it’s not going to solve everything, but it might make it a little bit better, because [a manufacturer] at the time, there was a lot of pedal confusion and that’s because they had it, the lift off the accelerator was almost like a braking effect, it was very strong regeneration and [the manufacturer] said they reprogrammed it to be more like a diesel bus”
Learning from other industries	TfL Health and Safety	“You know, waste vehicles, picking up rubbish, they’re stopping, they’re starting, they are moving through London, they are a similar style of driving, but they don’t appear to be getting this”

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